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STUDIES IN THE BRITISH FLORA.

By R. LLOYD PRAEGER, B.A.

VI.—THE LIFE AND DEATH OF BOGS.

WHEN deep turf-cuttings in a bog expose the base of the peat and the beds which underlie it, these, as has already been pointed out, frequently consist of white lake-marls; in other instances of black mud, the result of marsh conditions; or the peat may rest direct on gravel or Boulder clay or solid rock. It may be assumed fairly that a bog—that is, a spongy sphagnous vegetable mass—has generally had its origin in a marsh, which may in its turn have taken the place of a lake or pond. The marginal vegetation of a pond protrudes from the edge as a floating rim, which keeps on growing above, while the lower layers decay and their waste drops to the bottom and slowly builds up a solid foundation for the broadening rim, till the whole is filled with semi-solid ground. Every stage, from the open lakelet full of Charas and Pondweeds, which grow on the limy bottom, to the marsh with its tangle of Rushes and Sedges, may be studied in any locality where small sheets of water abound. The passage of marsh to bog is not so easily found, just as on the hill-slopes we fail to find fresh peat-bog forming on areas not already covered with peat. The explanation would appear to be that, as a matter of fact, fresh bogs are *not* forming—but more of this anon.

We may assume that when our peat-bogs were in their infancy, *Sphagnum* and its associated plants took possession of the ground when marshy growth had proceeded sufficiently far to ensure a permanently wet spongy subsoil. Once bog-growth was started, under the favourable climatic conditions which then prevailed, it may have proceeded with great rapidity, the bog-plants checking drainage, storing up water, and spreading ever from their centre. In this way the bogs rolled slowly outwards from the marshes or springs where they originated, and eventually overwhelmed great areas that had been well-drained land. On the hills, where higher rainfall gave increased facilities, the bogs spread up and down the slopes, enveloping whole mountain-ranges in a vegetable covering.

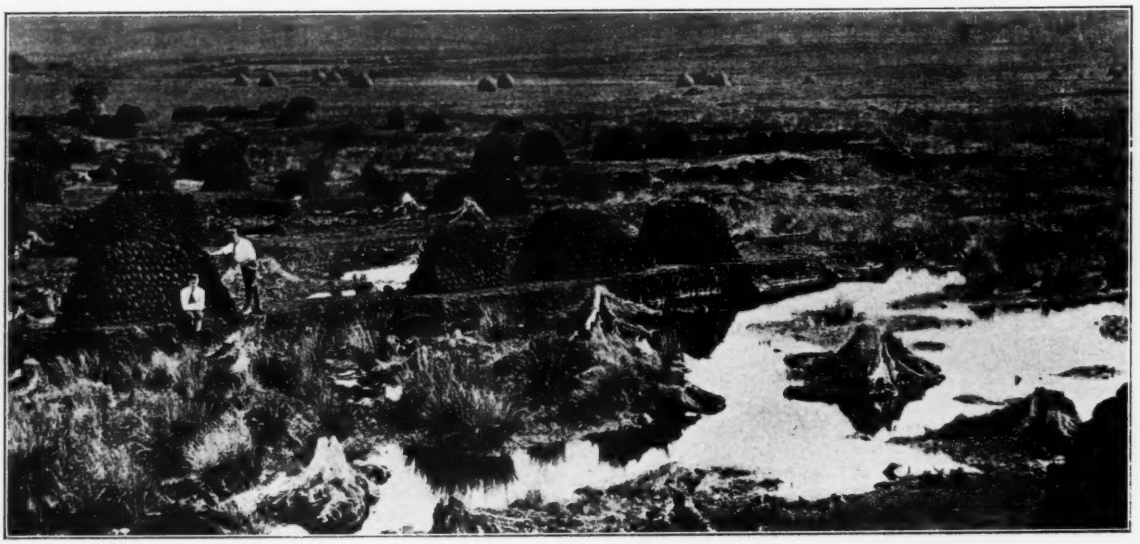
The lower layers of our peat-bogs are usually full of the stumps and roots of trees. The whole of the bog sometimes overlies these old forests, which, in such cases, as the roots show, grew on the surface of the clay or gravel which the bog afterwards covered. But in most instances the trees are rooted *in* the peat, and sometimes successive layers of tree-stumps show that several epochs of forest-growth occurred during the accumulation of the peat. The distribution of these trees, consisting chiefly of Scotch Fir and Oak, buried in bogs, deserves special consideration. They are found to extend in Scotland far north of the present limit of the species, while in Ireland, where the Scotch Fir is now extinct as a native, the remains of this tree occurs in enormous quantity throughout the land. In both countries the old forests appear at elevations in the mountains far beyond the present upper limit of the species. Along the exposed western coasts of Scotland and Ireland, enormous stumps may be dug out at various levels where now, even with artificial protection, trees will not grow. Not only that, but in numerous places round our shores, between tides, or even far below low-water mark, tree-bearing peat occurs. So that the evidence of the trees of the lower part of our peat-bogs indicates not only a somewhat different climate, which allowed a much wider extension of these forest-growths, but a greater elevation of the land. At Belfast a bed of peat, with Hazel and Scotch Fir remains, and bones of Red Deer and Wild Boar, occur at 27 feet below high-water mark, and the beds which overlie it prove that subsequent to its deposition a depression of 50 or 60 feet took place, followed by 30 or 40 feet of upheaval.* And not only have the sea-beaches and sea-bottom where these submerged trees occur been dry land, but, as Prof. James Geikie points out,† the luxuriance of the forest-growth which formerly flourished on what is now exposed and treeless coast, shows that at that period the shore-line must have been some distance removed; "there can be little doubt that at some time during the latest great extension of the European continent, the upraised beds of the Irish Sea, the English Channel, and the German Ocean, were included under the folds of that broad mantle of green forest, the relics of which are so conspicuous in our peat-mosses." Such an extension of the land would undoubtedly assist in supplying the comparatively continental climate and lessened exposure which would

* Praeger: "On the Estuarine Clay at the new Alexandra Dock, Belfast." *Proc.* Belfast Nat. Field Club, 1886-87. Appendix.

† James Geikie: "On the buried forests and peat-mosses of Scotland, and the changes of climate which they indicate." *Trans.* R. Soc. Edinburgh, XXIV., pp. 363-384. 1866.

account for the former wide distribution of pine and other woods. Similarly, the passing away of the forests, and their replacement by *Sphagnum* and the bog-flora, might well be connected with those geological changes which, giving our islands their present contour by depression of the land, brought in a milder and wetter insular climate. In our great peat-bogs, these forest-growths are confined to the lower layers. The main mass of the peat has been formed by *Sphagnum* and its associated plants after the forests passed away, and under the influence of a wet Cold-Temperate climate. The old forests have been deeply buried, and the bog-flora has reigned supreme in the British Isles, especially in the north and west, and since the beginning of history has furnished the most remarkable feature of the floral characteristics of our country.

So much for the origin and growth of bogs. Like everything else on this earth, their life is limited. They



Scotch Fir, with Peat above and below it; Co. Antrim.

[R. WELCH, *Photo.*

do not go on growing for ever, and it would seem that the Age of Bogs, as we may call it, through which these countries have been passing for the last few thousand years, is now on the decline. Prof. James Geikie is of opinion that bog-growth is waning in Scotland. Regarding this he speaks with no uncertain voice:—"A glance at the present aspect of our peat-mosses will convince any geologist that this formation has not only ceased to spread, but is in most cases rapidly diminishing. The moisture which in former times afforded it nourishment and support, has now become its chief enemy. Every shower of rain, every frost, gives fresh impetus to the decay; and leaving altogether out of account the operations of agriculture, we can yet have no doubt that natural causes alone would, in time, suffice to strip the last vestige of black peat from hill and valley. . . . The peat-mosses of Scotland are thus only a wreck of what they have once been."*

On the Irish bogs the signs of decay are not so general nor apparent, but many interesting individual cases may be studied. On the great red bogs of the Central Plain, bog-moss or *Sphagnum*, the plant which has been chiefly instrumental in building up the bogs, still grows luxuriantly, and there is no indication in many cases that the bogs are not still growing as fast as they ever grew. But on some bogs the luxuriant cushiony growth of *Sphagnum*, mixed with *Eriophorum*, *Narthecium*, *Rhynchospora*, gives place to a thin scrubby vegetation from which *Sphagnum* is absent, and among which the bare sodden peat continually forms black patches. Such a bog, though on level ground not yet actually wasting away, is dead so far as growth is concerned. Elsewhere a luxuriant crop of Ling replaces the many-coloured *Sphagnum*, and tells of a diminution of water supply. Such a bog is near its end, for Ling cannot form peat. But it is on the hills, among the black bogs, that signs of decay are most clearly evident, just as Prof. Geikie has pointed out as regards the Scottish hills. Thus, Kippure (2473 feet), the highest point of the Dublin hills, shows, even at a distance of some miles, a slightly serrated crest. This is found on ascending to be due to the fact that the great cap of peat, 12 feet or more in thickness, has been cut into by wind and rain, and eaten away till stretches of bare disintegrated granite alternate with great bastions of peat, capped with a growth of Ling. Peat so exposed will disappear rapidly. Rain, frost, and drought alike play havoc with it, and wind and streamlets carry it down the hill-side. In many other places, where deep deposits of peat prove a former luxuriant bog-flora, the vegetation now consists of dry wiry grasses, such as *Nardus stricta*, with stunted Ling and Whortle-berry. Such a plant-group will never form peat; the plants which made the deposit on which they grow are dead and gone. To compensate for the decay of the peat-flora, we do not find that in any portion of the country fresh bogs are forming; and we are driven to conclude that the formation of peat is on the decline. While man's operations are responsible for the destruction of much peat, by turf-cutting and by drainage and cultivation, this cause is wholly insufficient to account for the facts, as the best instances of bog decay are seen in situations which the operations of man have never extended to, or even indirectly affected. Some change of conditions must be looked for which has affected the whole country, and Prof. Geikie

* *Loc. cit.*, pp. 381, 382.

concludes, with much reason, that it is probably to be sought in a gradually diminishing rainfall.

There is another manner in which a bog may meet destruction—a way which is always dramatic, and sometimes may involve serious catastrophe. This happens when, owing to continual growth, the bog becomes unstable, and either slides bodily, or ruptures its walls and emits its contents. In order to understand how this takes place, we must study the structure of a bog. The thirty or forty feet of material which in a large peat-bog separates the surface from the underlying solid ground is not by any means of a consistency as firm as that of the surface layer. The intertwining stems and roots of the growing plants form a light matted felt which is comparatively firm, especially towards the margins of the bog; in the centre there are often holes in the crust, filled with mud or water, and connecting with the interior. This interior is fluid compared with the crust. The decomposed matter of the surface layers sinks to the bottom, and may form there a comparatively dense deposit, but the middle layers consist of thin mud, and often contain vast quantities of

An old Pine Forest on the edge of the Atlantic; Co. Sligo.
[R. WELCH, *Photo.*

water, which either descend from the surface in wet weather, or ascend from springs in the bottom of the bog. The felted crust is usually sufficiently strong to resist the pressure of the semi-fluid interior, even on large bogs which are situated on sloping ground; but exceptional circumstances may cause rupture An unusually wet season may swell the bog beyond the point of stability; or the stoppage of underground channels may cause great gatherings of water, and ultimate collapse of the crust; or turf-cutting injudiciously carried out may weaken the margin of the bog; and a bog-flow may result. These flows vary greatly in their character. The bog may slide bodily forward over its more fluid layers, so that the movement resembles a land-slide. This is, for instance, what happened in Joyce Country, Connemara, in September, 1821, when "upwards of a hundred acres of land, on which crops were growing and several families resided, were heard to emit a sound resembling thunder; the earth then became convulsed, and eventually this large tract moved down towards the sea, leaving the whole route over which it passed a complete waste."* A quaint and interesting account of a similar occurrence in Co. Limerick in 1697 may be read in the *Philosophical Transactions*†:—

"On the 7th day of June, 1697, near *Charleville*, in the County of *Limerick*, in Ireland, a great Rumbling, or faint Noise, was heard in the Earth, much like unto a Sound of Thunder near spent; for a little Space the Air was somewhat troubled with little Whisking Winds, seeming to meet contrary Ways: And soon after that, to the Greater Terror and Afrightment of a great Number of Spectators, a more wonderful thing happened; for in a Bog stretching North and South, the Earth began to move, viz., Meadow and Pasture Land that lay on the Side of the Bog. . . . This Motion began about Seven of the Clock in the Evening, fluctuating in its Motion like Waves, the Pasture-Land rising very high, so that it over-run the ground beneath it, and moved upon its Surface, rowling on with great pushing violence, till it covered the Meadow, and is held to remain upon it 16 Feet. . . ."

In many other cases the bog has burst instead of slid. A few reports of such occurrences may be quoted:—

"A large bog of 1500 acres, lying between Dundrum and Cashel, in the County of Tipperary, began to be agitated in an extraordinary manner, and to the astonishment of and terror of neighbouring inhabitants. The rumbling noise from the bog gave the alarm, and on the 30th it burst, and a kind of lava issued from it . . . . overspreading and laying waste a fine tract of fertile land. . . . . Everything that opposed its course was buried in ruins. Four houses were totally destroyed, and the trees that stood near them torn up by the roots."‡ Again, "After a sudden thaw of snow, the bog between Bloomfield and Geevah [Co. Sligo] gave way; and a black deluge, carrying with it the contents of 100 acres of bog, took the direction of a small stream, and rolled on with the violence of a torrent, sweeping along heath, timber, mud and stones, and overwhelming many meadows and arable land. On passing through some boggy land, the flood swept out a wide and deep ravine, and a part of the road leading from Bloomfield to St. James's Well was completely carried away from below the foundation for the breadth of 200 yards."§ In some cases the disturbance, at least at first, was local, and clearly caused by the undue accumulation of water, presumably owing to stoppage of the ordinary drainage channels. For instance, from an account of the bursting of a bog in Co. Antrim in 1835, sent to the *Magazine of Natural History*,‖ we gather that during one day a portion of the surface of the bog swelled up till the convexity was 30 feet in height, when with a noise like a rushing wind, it sank several feet, ejecting tufts, mud, and water; two days later the same movement was repeated, and eventually a great discharge of mud and water took place. The liquidity of the discharged interior varies greatly in different cases. As we have seen from some of the quotations above, the flow sometimes assumes the form of a rapid torrent. On the other hand, in one instance a farmer, digging potatoes, looks up to discover a brown mass creeping across the field towards him.¶ And Sir William Wilde states that in the well-known bog-flow of Kilnalady, in King's County, the bog-stuff "moved down the valley at the rate of about 2 yards an hour, with a

* "Census of Ireland, 1851," Part V., Vol. I. p. 90. 1856.

† *Phil. Trans.*, Vol. XIX., pp. 714-716. 1697.

‡ *Gentleman's Magazine*, Vol. LVIII., p. 355. 1788.

§ Lyell: "Principles of Geology," 10th Ed., Vol. II., p. 504.

‖ *Mag. Nat. Hist.*, Vol. IX., pp. 251-261. 1836.

¶ Savage: "Picturesque Ireland," pp. 234, 235.

front 200 yards wide and 8 feet deep."* In both the cases last quoted the catastrophe was clearly traceable to unscientific turf-cutting. To the same cause is to be attributed the fatal bog-flow of 28th December, 1896, near Killarney, whereby Lord Kenmare's quarry steward, his wife, and six children, lost their lives, and much arable land was destroyed. The writer can speak from his own knowledge of this bog-flow, having visited the ground and prepared, in conjunction with Prof. Sollas, a report† to the Royal Dublin Society on the catastrophe. This was a large bog, 750 feet above sea-level, lying on a watershed, and draining in three directions. The rupture took place along the face of a turf-cutting, and a vast flood poured forth, overwhelming two roads and the cottage in which the unfortunate Donelly family were asleep, and rushed down the valley with diminishing violence till it reached the Lake of Killarney, fourteen miles away, in which some of Donelly's furniture was afterwards found floating. The flood continued in diminishing quantity for five days, not regularly, but intermittently, as fresh portions of the bog gave way, with loud noises, and slid into the torrent, the lighter upper crust being borne along in floes on the surface of the inky flood. Before the outburst, the surface of the bog had been convex. When the flow subsided, a valley extended from the point of collapse, over the greater portion of the bog, 7 furlongs long by 5 furlongs wide, with a maximum depth of 28 feet. As the former height of this part of the bog above the margin of the depression was some 7 feet, it follows that the total maximum subsidence amounted to 35 feet. Here, and along the centre of the new valley, the bog was completely evacuated, the white bottom gravel showing among the stranded floes of surface crust. A well-marked lip marked the margin of the disturbed area. Inside this, the crust was broken by a series of parallel crevasses, caused by the slipping in of bog, and filled with water and bog that had risen from below. These crevasses were narrow at first, becoming wider further in, till near the centre line of the flow the area of heathy surface was small compared with that of semi-liquid peat.

Calculation of the volume enclosed between the surface of the bog before and after the catastrophe showed that six million cubic yards of material had been discharged, the greater portion of it within the first few hours of the outburst. This matter consisted of water charged with bog-mud, and carrying along with it great lumps of the more solid crust of the bog, innumerable stools of Scotch Fir from the lower layers of the bog, with trunks of trees and every other movable or breakable thing that the flood encountered. As the discharge lessened, these were left stranded, and the sight of the valley filled with black slime, out of which stumps and roots protruded like wildly waving arms, and in which, no man knew where, the naked corpses of the Donelly family lay entombed, was melancholy in the extreme. The high-water mark of the flood was rendered conspicuous by the fact that there was deposited the lightest portion of the material, forming an abrupt lip two feet in thickness, which, in our report, we likened to outpoured oatmeal porridge.

It will be noted that all our examples of bog-flows have been drawn from Ireland. Ireland is, indeed, not only as regards Europe, but as regards the whole world, essentially the country both of bogs and of bog-flows. A recent estimate shows that in spite of continued reclamation, 1861 square miles, or one-seventeenth of the whole surface of the country, is under low-level peat-bogs. As regards bog-flows, Klinge,* one of the most recent investigators of the subject, after a diligent hunt through European literature, produces records of but two occurrences of the kind outside Ireland. To these, Prof. Sollas and the writer have added but two others; these four are located, one in England (Solway Moss), one in Germany (Treuenfeld, Oldenburg), and two in the Falkland Islands, off Cape Horn. In Ireland bog-flows are of comparatively frequent occurrence. Seventeen are listed in the report on the Kerry flow, already referred to, and many have passed unrecorded.

* "Census of Ireland, 1851," Part V., Vol. I., p. 189. 1853.

† *Sci. Proc.* R.D.S., Vol. VIII., N.S., Part 5. 1897.

DR. AITKEN ON SUNSHINE AND CLOUDY CONDENSATION.

By Dr. J. G. McPHERSON, F.R.S.E.

ALTHOUGH no man has wrought so hard as Dr. Aitken to establish the principle that clouds are mainly due to the existence of dust-particles which attract moisture on certain conditions, yet even twenty years ago he said that it was probable that sunshine might cause the formation of nuclei, and allow cloudy condensation to take place where there was no dust.

Robert von Helmhotz and Professor Richarz, in their very beautiful experiments made with the steam jet, endeavoured to show that cloudy condensation was due to the molecular shock produced by the chemical processes going on in the neighbourhood of the jet. This theory Dr. Aitken has ingeniously exploded in his communication to the Royal Society of Edinburgh. He says: "Supposing we even admit that a molecular shock of the kind could determine condensation in a supersaturated vapour, it must be remembered that the degree of supersaturation in a steam jet in the open air where there is dust is extremely slight—the particles of water are so close that any strain easily relieves itself. Further, it must be remembered that the vapour in the jet is nearly in equilibrium with the drops of the size present in the jet."

There must, therefore, be some other means of accounting for cloudy condensation, in cases where there is no dust. Under certain conditions the sun gives rise to a great increase in the number of nuclei. Accordingly, Dr. Aitken has carefully tested a few of the ordinary constituents and impurities in our atmosphere to see if sunshine acted on them in such a way as to make them probable formers of cloud-particles.

He tested various gases, with more or less success; and he has communicated his results to the Society. He found that ordinary air, after being deprived of its dust-particles, and exposed to sunshine, does not show any cloudy condensation on expansion, but when certain gases are in the air a very different result is obtained.

He first used ammonia, putting one drop into six cubic inches of water in a flask and sunning this for one minute; the result was a considerable quantity of condensation even with such a weak solution. When the flask was exposed for five minutes the condensation by the action of the sunshine was made more dense. Though double the quantity of nitric acid was put into six cubic inches of water, the condensation was not so dense.

Hydrogen peroxide was tested by Dr. Aitken in the same way, and it was found to be a powerful generator of nuclei. Curious is it that sulphurous acid is puzzling to the experimentalist for cloud formation. It gives rise to condensation in the dark. On some days it was impossible to get the condensation to cease entirely. But sunshine very conclusively increased the condensation.

Sulphuretted hydrogen, which one always associates

* Ueber Moorausbrüche. *Bot. Jahrbücher*, Bd. XIV., p. 426. 1892.

with the smell of rotten eggs, gave dense condensation after being exposed to sunshine. Chlorine was one of the most interesting of the gases tested by Dr. Aitken, as it caused condensation to take place without supersaturation.

In his investigations, Dr. Aitken considered how long these nuclei, due to the action of sunshine in certain gases, would remain active for cloudy condensation. But he is not yet prepared with very satisfactory results. Some are very short-lived—fifteen minutes to half-an-hour being sufficient for the diluted hydrogen peroxide in the flask to lose its power of cloudy condensation; while the nuclei from sulphurous acid remained active for a considerable time.

He is now convinced that it is possible for cloudy condensation to take place in certain circumstances in the absence of dust. This seems paradoxical when we remember Dr. Aitken's beautiful experiments twenty years ago; but in ordinary circumstances dust is needed for cloud formation. However, supposing there is any part of the upper air free from dust, it is now found possible, if any of the gases experimented on be present, for the sun to convert them into nuclei of condensation, and permit of clouds forming in dustless air, miles above our atmosphere.

In the lower atmosphere there are always plenty of dust-particles to form cloudy condensation, whether the sun shines or not. But in the higher atmosphere, and in the region above our atmosphere, clouds can be formed by the action of the sun's rays on certain gases. This is a great boon to us on the earth, for it assures us of clouds to defend us from the sun's extra powerful rays, even when our atmosphere is fairly clear. Dr. Aitken's communication is of some meteorological importance; but he is cautious, and we wait for his more matured conclusions.

ASTRONOMY WITHOUT A TELESCOPE.

By E. WALTER MAUNDER, F.R.A.S.

XIX.—THE COLOURS OF STARS.

IN concluding my review of departments of observation open to the "astronomer without a telescope," I wish to glance at one which offers him some small opportunity, although in general it must be considered one for the possessors of telescopes and those even of considerable size.

The wide difference which there is between star and star as to brightness is apparent on the very first glance towards the heavens; it requires a more careful scrutiny to realize that they differ also in their colour and in the character of their shining. The ancients carried their discrimination of the difference in the brightnesses of stars so far as to recognise six magnitudes, and added the further refinement that they noted many stars as being somewhat brighter or somewhat fainter, as the case might be, than the average star of their magnitude, but when it came to the question of colour they hardly noted any differences at all. The stars in general were described as yellow, six only being recorded as "fiery." Of these six we should class five as being distinctly orange or red—Antares, Betelgeuse, Aldebaran, Arcturus and Pollux. The sixth, Sirius, is to us an intensely white star, and there have been many discussions as to whether it has changed its colour in the last 2000 years, or whether the description given of it—"fiery red"—is due to some mistake in the record, or whether the excessive scintillation of the star may account for it. For, as we see it now when near the horizon, a momentary flash of vivid red flames out from time to time, due to the irregular dispersion of its light in passing through the tremulous atmosphere. It is from this that Tennyson, most exact of all the poets in his scientific references, calls Sirius "fiery" in the well-known passage from the "Princess":—

> "The fiery Sirius alters hue
> And bickers into red and emerald."

A careful comparison of star with star will soon show that this classification is far from exhausting the differences of tint which may be recognised amongst the stars visible to the naked eye. Indeed the Star Colour Section of the British Astronomical Association, under the able and energetic direction of Mr. W. S. Franks, F.R.A.S., some few years ago drew up a catalogue of all the stars of the fifth magnitude and brighter, and recognised no fewer than twenty different tints or shades. The immense majority were indeed white, or white with a more or less evident tinge of yellow, up to a fairly full yellow, and the observations were made for the most part by means of refractors of three to four inches in aperture, or of reflectors of six to eight inches. The observer, therefore, who has no telescope, or who at best possesses but a good field-glass, would neither be able to deal with stars so faint as the fifth magnitude, nor to detect as many differences of colour.

Nevertheless, with a good field-glass some three hundred stars would be within his reach, and with the naked eye alone quite one hundred, the colour of which he might successfully estimate, and in all probability with patience and experience he would succeed in grouping these into fully a dozen different categories. The work would soon be felt to be an attractive one, for delicacy of discrimination would be sure to come with practice; and the sense of the power to discriminate with quickness and certainty between two stars which at first glance showed no difference would certainly bring pleasure.

In the work of estimating the colours of stars, there are two different points to keep in mind. The one is, what point in the spectrum should be taken as best representing the dominant tint of the star. The other, what is the intensity of that tint, for it must be remembered that the stars give continuous spectra, that is to say, the groundwork of their spectra is essentially continuous. Roughly speaking they all give light of all wave-lengths; in other words, they shine essentially by white light. We have no stars with spectra limited to one particular region. Even in the banded spectra none of the seven colours that we ordinarily recognise are entirely wanting, and even if we went further, as we easily might, and divided the spectrum not into seven only, but into twelve or more different colours the same statement might hold good.

We must therefore regard the stars as shining essentially by white light. But the various tints which together go to make up a perfect white, are not always found in their exact proportion. We may regard, therefore, a coloured star as a star shining by white light plus a certain proportion of light of one or more specific colours.

Assuming that this is so, that the light of any star is partly white and partly coloured, we may divide the stars into classes, depending entirely upon the depth of tint which they show, and not upon its colour. A five-fold division suggests itself, something to the following effect:—(1) pure white, (2) tinted, (3) coloured, (4) fully coloured, (5) deeply coloured. Amongst the stars visible to the naked eye the full and deep colours are rare; it is especially in the field of double star astronomy that we get the deeper and richer tints.

After the question of the depth of tint which the stars show, comes the question of the colour of that tint. For

naked-eye stars, the more refrangible colours do not come into consideration. The range is from orange-red up to yellowish green, or possibly in a single instance—that of Beta Libræ—to green. Alpha Lyræ, and possibly one or two other stars, have a distinct bluish tinge, but in general the stars not passed as white may be very well scheduled under one of the five following heads:—(1) reddish-orange, (2) orange, (3) orange-yellow, (4) yellow, (5) yellowish green.

In working upon star colours with the field-glass or naked eye it is impossible to use any artificial standard of colour, but the wide field of view, and the ease and rapidity with which the attention can be turned from one part of the heavens to the other, will much more than make up for this deficiency. The stars must be compared one with another, and the estimations of colour must be purely relative, and the method will be found much the most accurate possible.

The most satisfactory programme for an evening's work would probably be to take a number of stars not differing too widely in magnitude, and without regard to the exact name to be given to the depth of tint of each, to arrange them simply in order of colour intensity, beginning with the star of purest whiteness and going downwards to the one that showed the fullest tint. It would probably be found well for the sake of simplicity to keep this work of the arrangement in order of the depth of tint entirely separate from the work of arrangement in order of colour. For several nights a large number of stars should be taken and carefully compared, each one with the others, until a satisfactory progression has been arranged for the whole number; the depth of tint being the criterion. Then, when this work has been carried out successfully, a similar comparison should be instituted as to the colour of the stars, ranging them in order from the reddest to those which show the nearest approach to green; and in this second comparison it would probably be found useful to confine the work at first only to the stars of deep tint, then to those of full colour, and so on, until last of all those are classified according to the spectral order of their colours which are only slightly tinted. Thus, if a hundred stars have been selected as showing some more or less appreciable tint, and have been arranged in order of the depth of tint, number 100 being the star of deepest tint, then numbers 61 to 100 might be the subject of the first arrangement in spectrum order, numbers 41 to 80 of the second, and so on.

The great advantage of making the colour estimations purely comparative would be that in the case of any variation of colour in any star its detection would be easier, and much more free from ambiguity than by any other method. Thus Klein and Weber state that Alpha Ursæ Majoris passes through a series of colour changes in a period of 33 days. Several telescopic stars are supposed in like manner to have changed their colour. The case of Sirius has already been referred to, but whatever it may have been in classical times, it certainly has shown itself unvarying white in our own day. Algol, also a white star to us, is described by Al Sufi as "red." It is therefore not impossible that the systematic study of star colours, even though it be undertaken by the naked eye alone, or at best with the assistance of a field-glass, may yet succeed in discovering an instance of colour change. But should it fail to do so, it must not be forgotten that the clear and unmistakable evidence, which a thorough and systematic record of the relative colours of stars would supply, that no colour change had occurred, would be just as valuable, just as important.

Closely connected with the colour of stars is their mode of shining; in other words, their scintillation. The blue stars and white stars, like Vega and Sirius, "twinkle" the most rapidly; the orange stars shining the most steadily. The planets ordinarily do not scintillate. This scintillation is, of course, due to tremors in our own atmosphere, since the stars are to us absolutely mathematical points to which not even the most powerful telescope has yet succeeded in giving any appreciable diameter. It follows that when the air through which the star's rays pass to our eye is in great agitation, many rays may reach us one moment and few the next, and the star may seem to flicker like a candle in the wind. The planets do not scintillate because they show to us real disks, even though these are not large enough to be perceived as such by the naked eye. The one exception, the planet Mercury, is an exception partly because it is always near the horizon when seen with the naked eye, and partly because its diameter is very small. It owes its Greek epithet στιλβων, "glittering" or "flashing," to this peculiarity amongst the older planets.

The measurement of the amount, or, rather, rapidity of scintillation, lies beyond the power of the "astronomer without a telescope," but even to the naked eye there is a marked difference in this respect between star and star, and the observer will not be able to overlook its evident connection with the star's colour.

The review of the various departments of observation, available to the unassisted sight, has thus brought us to studies, as in the case of variable stars and star colours, where, though there is a certain amount of work to be done without optical aid, yet the observer's field is much increased by the possession of a good opera-glass or field-glass.

We have come as it were to the threshold of that noble structure which has been built up by means of the telescope and spectroscope; but to that building there are many guides, and to explore it lies beyond my present task. The purpose which I have set before myself has been a much humbler one, but if I have succeeded in arousing interest in those astronomical phenomena which require no "optic glass" for their display, I shall be well rewarded.

And I think that he who seriously undertakes some department of astronomy without a telescope, will likewise not fail of his reward. The growth in the power of perception which careful practice in observation brings is a real gain. Real too is the gain in habits of system and method. For to perceive is but a part of the astronomer's work; he must learn to record what he has perceived, and must form the habit of recording at once and recording in order. And this habit, as well as the gain in perception, means increase of power, and power gives pleasure. Pleasure there is too in gaining as it were from direct converse with nature, fresh insight into her mysteries; pleasure, if our knowledge is really increased; pleasure, too, even if the problems prove too involved for us and our only progress be towards a truer appreciation of their difficulty.

The fields of work which we have passed in review have been both many and varied. They have extended from phenomena the most slight and transient—the lighting of a sunset cloud, the momentary flash of a meteor—to the greatest and most enduring that the universe can show—the fabric of the Galaxy and its interweaving with the stars. And there is above all in this direct study of the heavens, out in the open, beneath the deep unsounded sky, a charm and an awe, not to be realised otherwise. It is nature at her vastest that we approach; we look up to her in her most exalted form. We see unrolled before us the volume which the finger of God has written; we stand in the dwelling-place of the Most High.

XUM

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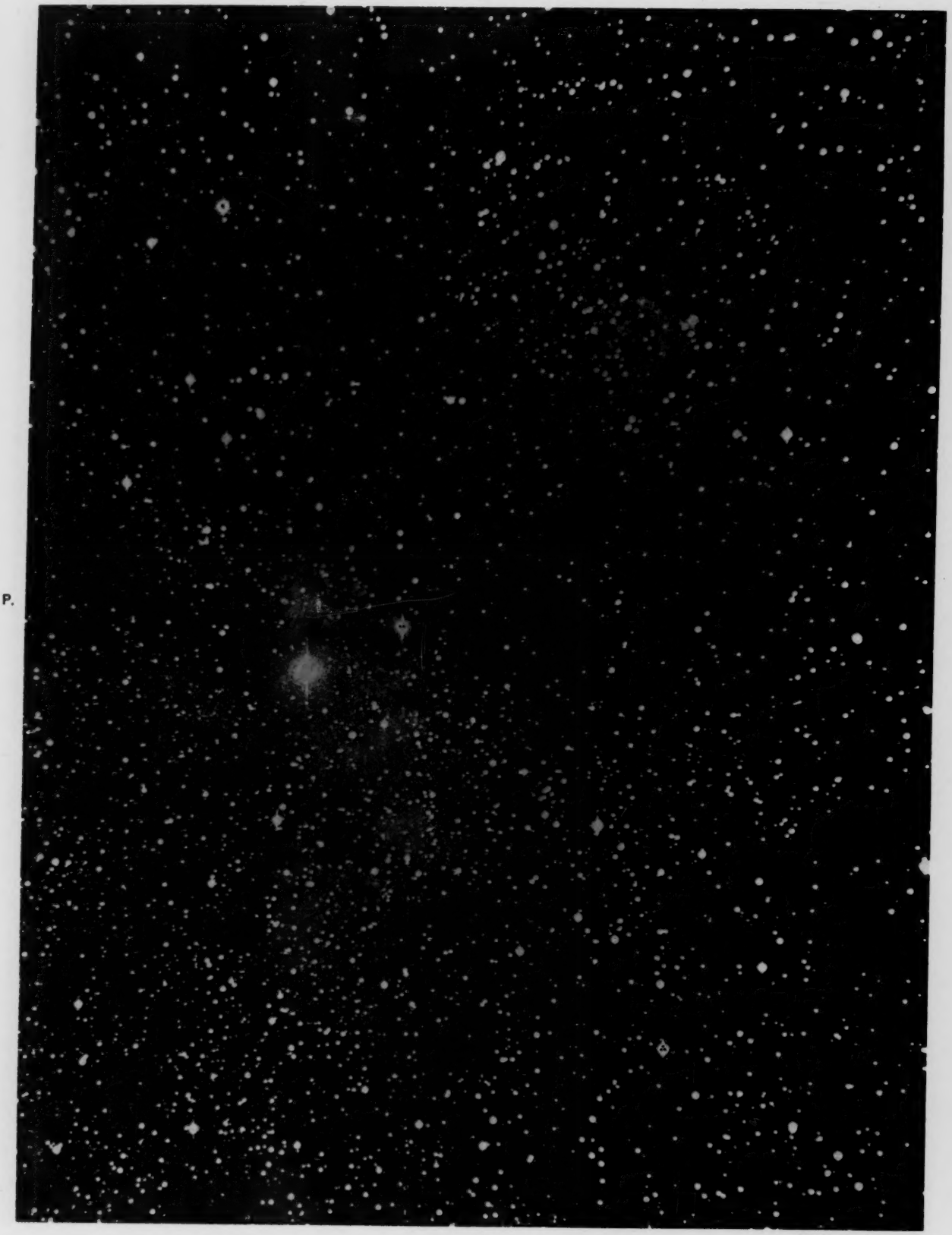
NEBULÆ INDEX CATALOGUE 1318 CYGNI.

By ISAAC ROBERTS, D.Sc., F.R.S.

S.



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PHOTOGRAPH OF THE NEBULOUS REGION ON THE FOLLOWING SIDE OF GAMMA CYGNI.

By ISAAC ROBERTS, D.SC., F.R.S.

THE photograph annexed is of the region of the sky comprised between R.A. 20h. 20m. 25s. and R.A. 20h. 26m. 50s., and in Declination between south +39° 12′·0 and +40° 48′·5 north. The area, therefore, is 6m. 25s. in extent from *following* to *preceding* and 1° 36′·5 from north to south. Scale—one millimètre to twenty-four seconds of arc.

Co-ordinates of the fiducial stars marked with dots for the epoch 1900:—

Star (.) D.M. No. 4178. Zone +39° R.A. 20h. 21m. 51·5s. Dec. +39° 27′·9. Mag. 7·5.
Star (..) D.M. No. 4193. Zone +39° R.A. 20h. 23m. 7·6s. Dec. +40° 1′·0. Mag. 7·7.
Star (...) D.M. No. 4188. Zone +40° R.A. 20h. 24m. 58·2s. Dec. +40° 34′·1. Mag. 8·0.

The photograph was taken with the 20-inch reflector, and exposure of the plate during 90 minutes on the 5th September, 1901, and, like the many other nebulæ which I have photographed during the past fifteen years (some of which have been published in KNOWLEDGE and in my two volumes of *Stars, Star-Clusters and Nebulæ*), it presents characteristic features of aggregation into definite *loci* which will probably develop into separate nebulæ; some of them assuming, under the stress of disturbance and gravitation, the form of spiral nebulæ; these again will develop into stars and clusters of stars.

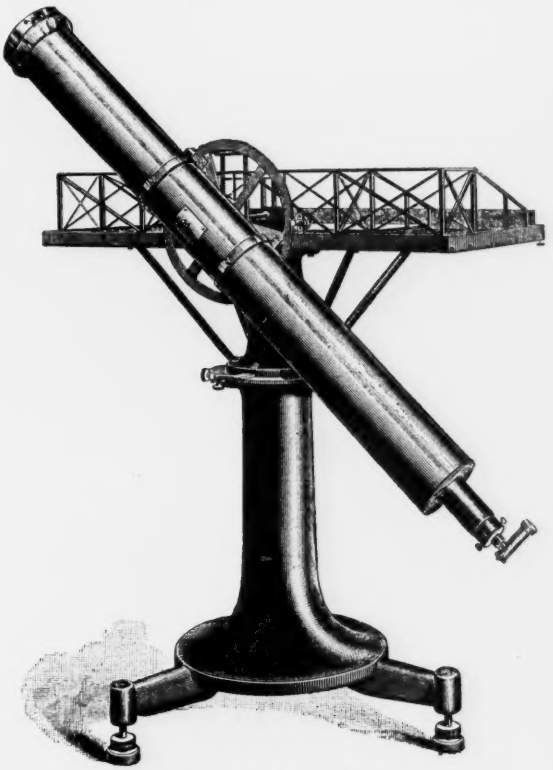
In this manner does the evidence, which has been accumulated by the aid of photography and by eye observations, lead us to the inference that changes—eternal changes—are part of the order of Nature, whether we view them in the inconceivable distance of space amongst the stars and nebulæ, or in the smallest microscopic compound or organism on this relatively small speck of earth. The results are consistently identical in principle, that the older forms of matter are disintegrated and afterwards reconstituted into new forms of aggregated matter and of life. This appears to be invariably the grand order of the laws of Nature.

THE DURHAM ALMUCANTAR.

By Prof. R. A. SAMPSON, M.A.

IN the problem of mapping and measuring the skies, general attention has of late years been directed mainly to the work that can be done with a photographic equatorial, that is to say, to the task of completing the astrographic plates, and of devising satisfactory methods of measuring and recording them. But at least among those professionally engaged in astronomy this is not due to any neglect of another and more fundamental branch with which the equatorial cannot compete. One recalls that Bessel gave the name *Fundamenta Astronomiae pro anno* MDCCLV. to his discussion of Bradley's transit results. For the measurement of large distances upon the sky and fixing all the critical points, the transit circle and clock have hitherto been the sole authorities. Now, no matter how good a method may be, it is always preferable to check its results by a different method than to repeat them. Take what precaution we may, each system almost certainly brings with it its own systematic faults, which it is next to impossible to eliminate; hence there is very great importance attaching to a radical variation of the design of instrument and system of observation of transit work. The transit circle has held its own in the past against more than one such rival. The two altazimuths at Greenwich occur to us at once as instances. A variation of the traditional design of transit circle was suggested by the late Mr. E. J. Stone in 1881, in which there was no tube at right angles to the conical axis about which the instrument revolved, but in the centre of this axis the light fell upon a prism which diverted the rays so that the eye looked through this axis when observing, and the third face of the prism was curved to give the necessary deviation to the rays. This instrument was never made. Up to the present time, the undivided credit of inventing and using an instrument and method which are exact enough to check if not to outdo the determinations of the best transit circles belongs to Mr. S. C. Chandler, of Boston, U.S.A.

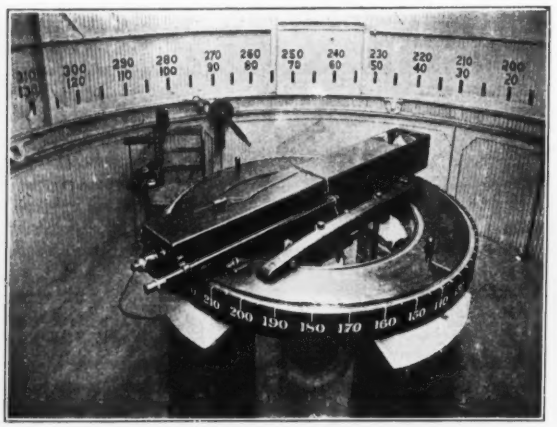
"The idea occurred to me about eight years ago," Mr. Chandler writes in 1887, "of substituting for the meridian as a fundamental plane of reference, the small circle



Chandler's Almucantar.

perpendicular to the meridian passing through the pole; and for the motion of rotation determined mechanically by the pivots of a horizontal axis, one determined by gravitative action about an imaginary vertical axis. Two ways of doing this suggested themselves. The instrument might be suspended like a pendulum, or it might be floated upon mercury." Experiments decided in favour of the latter method, and after making a small trial instrument and obtaining from it results of unexpected accuracy, Mr. Chandler, in the years 1884 and 1885, used facilities placed at his disposal by the director of Harvard College Observatory to make a more searching study of the possibilities of his invention. In this research he employed a new instrument, with a telescope of 4 inches aperture. It was mounted on a tripod stand, which carried a horizontal trough which could rotate in azimuth; this

trough contained mercury, and in it rested a float which carried the telescope. The float was held in place by pins running in slots, which were intended to allow the float to level itself in the mercury, while forbidding motion in azimuth. An axis held the telescope beyond the float clear of the trough, so that it could be clamped at any



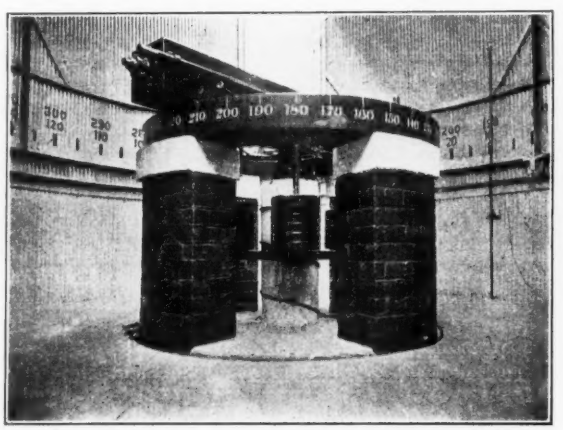
The Case College Almucantar.

altitude. This instrument Mr. Chandler called an "almucantar." The term "almucantar" has almost gone out of use in recent books, but in older ones we find it. For instance, Delambre gives "*Almicantarat*, terme arabe; c'est un petit cercle parallèle à l'horizon, et dont les pôles sont le zénit et le nadir." It is clear that the optic axis of the instrument described above, when clamped in altitude and moved in azimuth, traces out a horizontal circle upon the sky, and the accuracy with which it does so depends only upon the accuracy with which the floating parts regain their old orientation with respect to the vertical, after the disturbance that occurs when the azimuth is changed.

In actual use the altitude is always such that the centre of the field passes through the pole, or rather differs from it by a small collimation constant, which is determined afresh each night. Spider lines are placed horizontally at the eye-end, and the co-ordinates of a star are found by two time observations of its transits east and west of the meridian as it is carried across the circle of observation by the earth's rotation. Azimuth is used only for the purposes of setting, and does not appear in the result.

Mr. Chandler's observations, of the merits of which I shall speak later, were discontinued in 1885, and found no one to carry them on till the year 1900. In that year, in the month of February, the Durham almucantar was set up, and in March Prof. C. S. Howe erected one at Case College, Cleveland, Ohio. I give figures of each of these instruments, for their differences illustrate well the flexibility of the design. The Durham almucantar and that of Case College are each of six inches aperture, that is to say, of as great power as any transit circles, excepting one or two of the largest. In both the telescope axis is horizontal, the view of the skies being gained by the intervention of a plane mirror; in both the trough and float are made of cast iron, and allow about the same margin of mercury at the sides. Beyond this we might almost say that if two instruments had been designed by the same man to experiment upon the different ways of doing the same thing, they could not have served that purpose better, and we may expect interesting results as to which form is preferable from the comparison of the Durham results with those of Prof. Howe. In the Durham instrument the mirror is behind the object-glass, and different altitudes are secured by rotating the telescope tube in Y's; in the other the mirror is exposed, and is itself in slight degree adjustable. In the former the trough is rectangular, with sides about 2 feet by 3 feet and about 2 inches deep, and forms part of a large table which turns about a vertical axis, carrying the floating parts with it, which are fixed relatively to it by means of brackets which bear against agate plates on the outside of the trough. In the latter the trough is ring-shaped, about 5 feet external diameter and $4\frac{1}{2}$ inches deep, and is fixed to the piers, the telescope and float turning in the trough, and guided in their motions by a pin at the centre working in oil. In the former the clamp and slow motion work upon the edge of the rotating table; in the latter they work upon an arm projecting from below the centre of the telescope, and designed so as to limit only the azimuth, and not at all the orientation of the floating parts with respect to the vertical. In both telescopes there is little doubt that this essential and that of rapid subsidence of oscillations after setting are fully secured. Without criticising Prof. Howe's design, I have found the rotating table in my own of the utmost convenience. I have now built up upon it a wind screen, which is designed to cover in entirely the floating parts. It will be seen in the plate that a long arm runs out from it, carrying an eye-guard; since the photograph was taken this has been removed, and the arm now carries the eye-piece itself with a sliding arrangement, so that the eye-piece is actually detached from the telescope. As to the success of this arrangement I was not very confident in advance, but it was necessary to try it, because oblique transits carry the star across the wires at the limits of the field. Happily it turned out a thorough success.

Now making a comparison of transit circle and almucantar in respect to their observations, there can be no doubt that although the almucantar is disturbed by each fresh setting, when the oscillations have subsided it



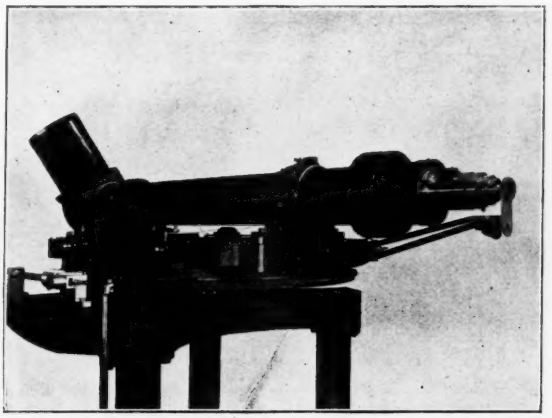
The Case College Almucantar.

resumes its old orientation to the vertical within perfectly insensible limits. The effect of this is the same as if in the transit circle we could write the errors of azimuth and level permanently at zero.

The corrections for refraction are immensely reduced, since observations are all made at the same zenith distance.

That for flexure of the telescope tube is abolished. The observer takes a natural attitude, the same for all stars, in place of inverting himself upon the usual observing couch. These are some of the advantages of allowing the axis of rotation to be determined by gravity and not by the instrument maker.

Of course the advantages are not all on one side. The transit circle can take every star that is visible; for the almucantar we draw a ring upon the sky, passing horizontally through the pole, and disregard all that is not carried across it; at Durham this limits us to stars not



The Durham Almucantar.

more than 70° from the pole; a more southerly latitude would be better, but, as we cannot change the latitude, we must be content that there is more work within reach than we can ever do. A complaint that will require more investigation is that the stars cross the wires obliquely. Each star cuts the wires at an angle equal to its hour angle at the time of transit, thus varying for different stars from a right angle at the pole to zero at the southern limit. As a consequence a change of declination produces more effect upon the transit of a southern star than upon one more northerly; and declinations are better determined for the former than the latter. Declination should be very well determined at the lower range of the instrument, for all the measures are absolute measures from the pole, not as in the transit circle, measures made by reference to a divided circle and some reflecting apparatus.

As to the calculations involved, I believe that when large numbers of stars are discussed the advantage lies with the almucantar.

Exactly what an almucantar observation gives may be shown by a diagram. The difference is observed between the times which we could predict for the star's passage, according to the *Nautical Almanac*, and the time at which it actually appears. This difference has to be shared in proper proportions between corrections to the latitude, if erroneous, to the clock, to the zenith distance of the telescopic axis, and to the co-ordinates of the star, for each of these contributes a share. The diagram below shows the amount of error in latitude, zenith setting, or declination which would contribute an error of 0ˢ·1 in a transit, and inversely it shows how accurately we may expect to determine these quantities by sifting them out from the inevitable errors of observation. The fact that all these unknown corrections are mingled together in a single statement of difference between observed and predicted times is no disadvantage. On the contrary, it is a positive gain; for it permits the ready application of the rule known as "Least Squares" for combining a set of observations to the best advantage so as to derive clock correction and the rest from them. At the same time, as everything is got out of the observation itself, the observer is relieved from vexatious supplementary measures of faults of adjustment of his instrument.

Dr. Chandler observed for thirteen months—or sixty-three nights in all. If the almucantar is to be a serious rival of the transit circle, such a series is not large enough to do it justice. Such a series, dating from when the instrument was first set up, might be expected to make out a *primâ facie* case, and point out promising lines of investigation. That it did this and more does not admit of question. It was confined to observations of stars in the catalogue of the *Berliner Jahrbuch*, and as these are very well observed stars, a rough and ready test of Dr. Chandler's success is to take the residuals which are to give corrections to co-ordinates of the stars, and see whether these depart much from zero. The first twenty stars upon his list which are not close to the limits of his range give thus ±0ˢ·086; if stars about 70° declination be omitted it becomes ±0ˢ·066. We may put this in the form, that a single observation used to determine right ascension would, on the average, depart so much from the truth, and this is based upon assuming that the *Berliner Jahrbuch's* places require no correction at all. If we make those allowances for a new instrument which anyone's experience will suggest—but which, be it remarked, Dr. Chandler himself does not claim—it is out of reason to expect anything finer.

But that the almucantar will do even better I believe we have already proved at Durham, though we have only emerged some two or three months from the difficulties of a start; in evidence of this I quote below the results of the last night's observations that have been fully reduced,* 1901, November 15. E. or W. attached to a star indicates

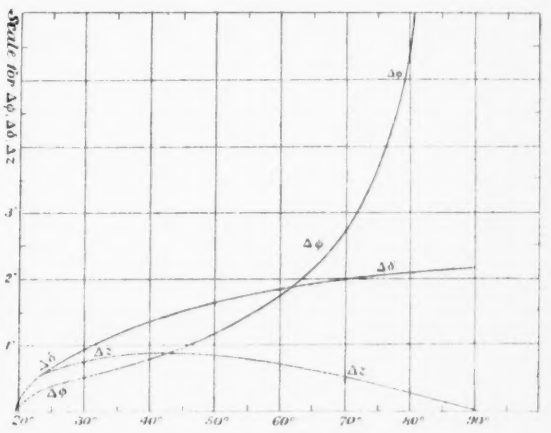


Chart of Almucantar Constants for Latitude of Durham Observatory (54° 46′ 6″·2 N).

Abscissa = declination of object.
Ordinates:—Δδ = error in deduced declination for 0ˢ·1 error in transit.
Δφ = " " latitude " " "
Δz = " " collimation " " "

the side of the meridian on which the transit was taken, and the fractions of a second opposite to it correspond to the numbers of which I have given the mean in Dr. Chandler's observations.

* This was written in January last.

	s.		s.
β Draconis, W.	−0·03	η Aurigæ, E.	−0·02
α Lyræ, W.	−0·07	γ Persei, E.	0·00
τ Pegasi, E.	−0·10	β Trianguli, E.	+0·02
ζ Draconis, W.	+0·09	Andromedæ, W.	−0·05
δ Andromedæ, E.	−0·03	β Pegasi, W.	+0·29
ε Andromedæ, E.	−0·08	ζ Persei, E.	−0·02
Ursæ Minoris, W.	+0·26	ε Aurigæ, E.	+0·15
32 Vulpeculæ, W.	+0·05	α Aurigæ, E.	+0·01
16 Pegasi, W.	0·00	α Cephei, W.	+0·05
β Persei, E.	+0·03	ζ Cygni, W.	−0·02

I put these numbers forward merely to give my readers a general idea of what we can do with the Durham almucantar. I do not wish at present to base any statement upon them as to the relative merits of the almucantar and the best transit circles; that must wait until observations have accumulated, and until some refinements of correction have been applied to them which were neglected in these first reductions. But in any case it is evident that an instrument that can do work like this at the very beginning of its use cannot be disregarded as a rival, no matter what other claimants are in the field.

THE CANALS OF MARS.

By B. W. LANE.

THE object of this paper is to describe a series of experiments which some friends and I have been performing with a view to the settlement of this matter. The results appear to me to offer a complete explanation of these appearances.

While reading M. Antoniadi's article on "Mars" in the April number of KNOWLEDGE, I was particularly struck by his statement that only one or two of the canals were ever seen at one time (I use the terms "canal," "sea," "gulf," &c., for convenience only). From this arose the idea that possibly the atmospheric vibrations might cause such an apparent lengthening of the gulfs on the planet as to suggest the canal sufficiently to make it visible in flashes. I accordingly determined to test the matter by means of hot air currents, and a drawing of the planet without any canals marked upon it, viewed by means of a telescope.

As a sort of chance, however, I made a blank drawing of the planet like Fig. 1, and placed it at a distance of ten feet from a friend of mine, and asked her to draw what she saw. As I say, it was only a chance experiment, and I did not expect any results, and was astonished when, after first saying (after drawing in the seas) that she could see nothing more, and then, gazing awhile, she drew in two lines resembling in general character those seen on the actual planet. The positions, however, were different from those given by Schiaparelli.

The original blank drawing, however, was slightly inaccurate, so, having made another as accurate as I could, copied from one of Schiaparelli's, I tried the experiment with the improved drawing on another lady. This time I drew the seas in roughly for her, and left her only to fill in anything else she could see. I was very careful not to suggest lines to her, in fact, to make certain, I mentioned spots and shading as the things to be looked for. In spite of this, however, after ten minutes' work she had produced—*copied off this blank drawing*—a drawing in all essential respects like Fig. 3. Fig. 3 is as accurate a copy as I could make from hers. Fig. 2 is Schiaparelli's drawing of the same region, with the canals inserted. It will be at once seen by comparison that the system produced by this optical delusion is precisely similar to that seen on the surface of Mars.

I have since experimented with two boys, both aged eleven years, who had never in their lives heard of either Mars or the canals. Their attempts are reproduced in Figs. 4 and 5. Again it will be seen that, with the exception of one canal in each drawing, they are all in the same positions as those of Schiaparelli.

Altogether I have experimented with five persons, of whom one only failed to see the canals on the blank

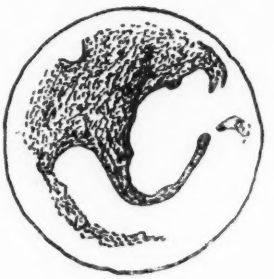


FIG. 1.

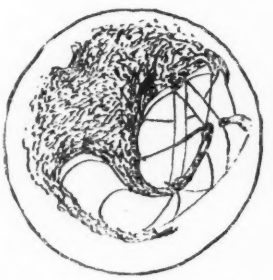


FIG. 2.

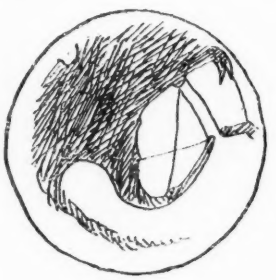


FIG. 3.

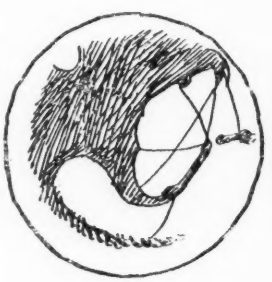


FIG. 5.

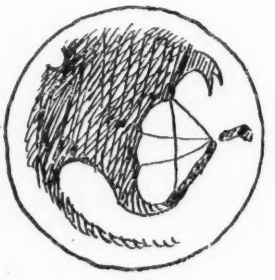


FIG. 4.

drawing. One of the boys refused to believe that the drawing I showed him was the same as that from which he had copied the lines, so certain was he that they had been actual realities. Two acquaintances of mine have both been instituting similar experiments and have arrived at identically the same results. Thus it appears probable that the mere shape of the oceans of Mars is sufficient to give rise to the appearance of the complicated system discovered by Schiaparelli.

As well as setting other people to do it, I have myself been mapping out the canals which I could see on this drawing. I do not give my map because it is identical with Fig. 2 except for about three minor lines. I have frequently seen these pseudo-canals doubled, and, when my eyes have been in the best condition, have seen not two canals only, but four or five at a time, and have sometimes seen one or more canals so firmly marked that I have had

to go up to the drawing to make sure in my own mind that I had not put a line there by mistake. When first looked for, very steady gazing is needed to see them at all; in fact, in my case it required two minutes staring before I could perceive the slightest fleeting indication. If another attempt be made, say next day, they are seen much more easily than at the first attempt, and the task of seeing them becomes easier every time, until now with me I can scarcely look at the drawing *without* seeing some one or two. The first time these canals are seen they appear as broad, misty, ill-defined bands, which easily change their places, but when a little practice has been had in seeing them they appear as firm hard lines, indeed, as Mr. Lowell puts it in speaking of the real canals, "like a steel engraving." In fact, I should say from what I have been able to gather respecting the appearance of the canals on the planet, it is easier to see canals on a blank drawing like Fig. 1 placed at a distance of 20 feet from the eye than to see them on Mars.

The above-described experiment can be performed by anyone having a blacklead and a piece of ordinary *rough* drawing paper. It must not be expected that everyone will be able to see these canals on the drawing, since everyone who has looked for them has not seen them on the planet, but two at least out of every three persons should be able to see them with steady gazing, if the diagram is of suitable size and placed at a suitable distance. The one used by me was $3\frac{1}{2}$ inches in diameter, and was placed at a distance of 20 feet in not too good a light.

It may be said that even though the ordinary canals could be produced by an optical delusion, such a complicated system as that of Elysium could not be the product of such a cause. All that is needed to produce an exact replica of this district is that an oval patch of the drawing should be made slightly lighter in colour than the surrounding paper, when contrast will at once cause the appearance of a circular canal surrounding it, from which the other canals branch. The side of the planet pictured in these drawings is not the only one which I have made use of. In fact experiments made with drawings of the other side were even more successful, and the *nettetté* of the canal known as the Hydraotes was at times truly startling.

It thus appears possible, since two systems may be seen, one on Mars, and the other on a drawing, which are not only analogous but identical in every particular (since any two observers differ as much as the drawings herewith reproduced), one of which is certainly produced by an optical delusion, that the other, viz., that seen on Mars, may also be due to the same cause. The facts that the canals are not best seen when the planet is nearest, and that canals have been seen on other planets, seem to point in the same direction. The fact that the directions of the canals change with the Martian seasons need be no hindrance to the theory of their optical production, since if they are so produced their direction and degrees of visibility depend on the shape of the Martian oceans, and since these change with the seasons, the canals will change also. It may be remarked that by not suggesting canals to the subjects of our experiments, we have put them in a more disadvantageous position for seeing them than anyone besides Schiaparelli has been in, since later observers not only heard of the canals but studied Schiaparelli's maps, and so aided any optical delusion which might exist. The above results, therefore, would have been fairly conclusive even if canals *had* been suggested.

Thus it would appear that those gentlemen who have seen the canals have, with the best intentions, been deceived by a most peculiar and almost incredible optical delusion—a delusion which has given rise to a system so complicated that no one has hitherto attempted to prove that the whole appearance was from beginning to end attributable to this cause, although many have asserted that such was the case.

[The first suggestion of the idea thus worked out by Mr. Lane occurred to me in 1882, when I noted how many of the Schiaparellian canals were prolongations of what other observers had drawn as indentations on the coast lines of Mars ("Observatory," Vol. V., pp. 136, 138). Later, in 1894, I made some experiments on the limits of visibility for dark markings on a bright background (KNOWLEDGE, 1894, November, p. 249), and incidentally noted, when irregular forms were at such a distance that the minutest details of their irregularities were too small to be separately defined, and yet were large enough to produce some impression, that it was easy to interpret such irregularities as parts of a network of straight lines. I further noted that under such circumstances, *i.e.*, when markings were too narrow or too small to be fully and distinctly defined, but yet were sufficiently large to be indefinitely glimpsed, the rendering in the case of narrow markings, however winding, broken or irregular, was that of straight lines; but in the case of compacter objects the rendering was of round dots. And narrower objects could be discerned as straight lines than as dots. Hence I ventured to foretell (KNOWLEDGE, 1894, November, p. 252) that the Schiaparellian canal system would be followed by the discovery of a system of "lakes"; a prophecy almost immediately fulfilled at the Lowell Observatory, by the detection of the "oases."

Acting on the suggestion of Mr. Lane's letter, and by the kind co-operation of Mr. J. E. Evans, headmaster of the Royal Hospital School, Greenwich, I have quite recently subjected a number of drawings of Mars—free from canals—to boys in that school, for them to copy. The result was striking. Four out of five drew no canals, but the remaining fifth supplied them. And it was clear that this was directly a question of their distance from the drawing. Boys near the drawing saw too well and distinctly to imagine spurious lines. Boys at a great distance could only perceive the leading features of the drawing. But those at mean distance, by whom the minor details were imperfectly perceived, in many cases rendered these by straight narrow "canals."

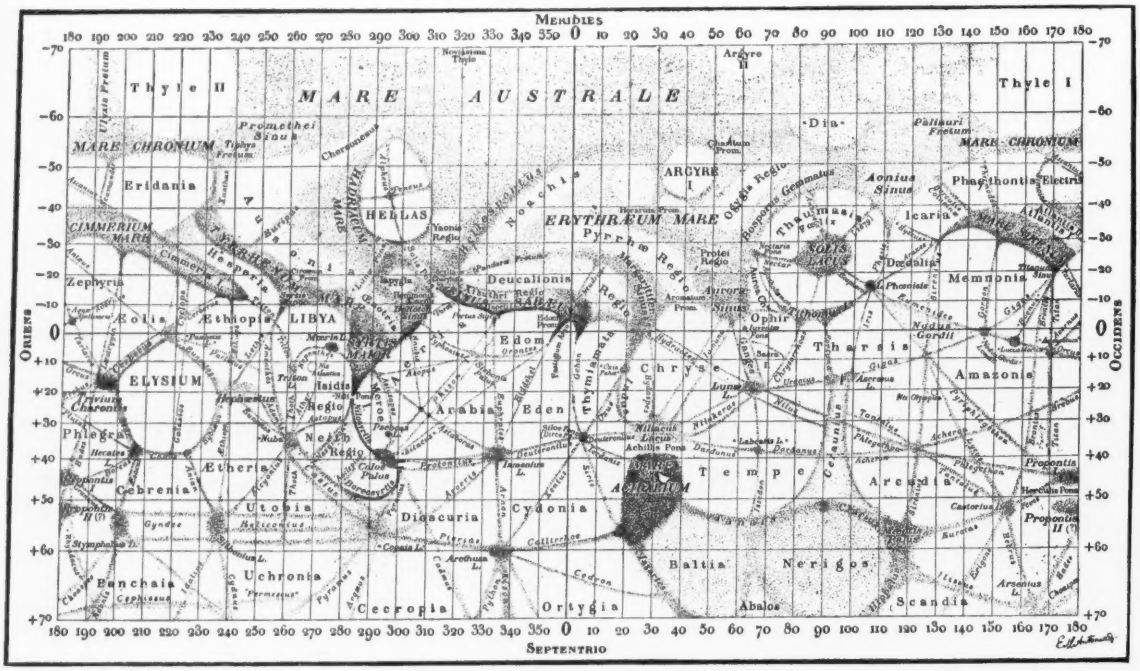
Yet I am not prepared to accept Mr. Lane's conclusion quite as he puts it. Some of the "canals" seem to have been detected with so low a power that their full and distinct definition would be well within the power of large and well-placed telescopes. Hence my own view of the "rendering" or "interpretation" of undefined objects would not enter into their case. Nor do my own experiments quite confirm his as to the canals presenting themselves to the imagination, unless there are minute markings present—however unlike the canals—to afford a sort of basis for them. *E.g.*, stippling lightly the general surface, but leaving Elysium free, was quite enough to create a polygonal system of canals around Elysium. But though the stipple dots were too small to have been separately and clearly seen at one-twentieth the distance, they or their equivalent had to be present, or no "canals" would have been seen.

Nevertheless, Mr. Lane's letter puts in a new and striking light a factor in the problem of Mars which, although almost entirely neglected hitherto, will have to be taken into full account in the future.—E. WALTER MAUNDER.]

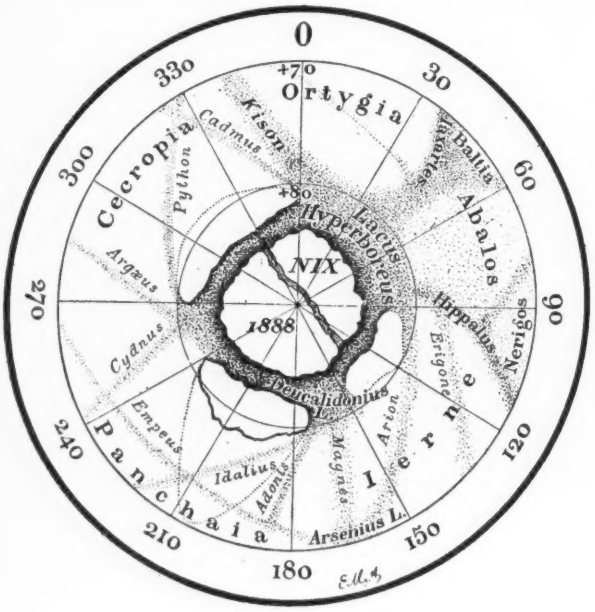
XUM

CHART OF MARS.

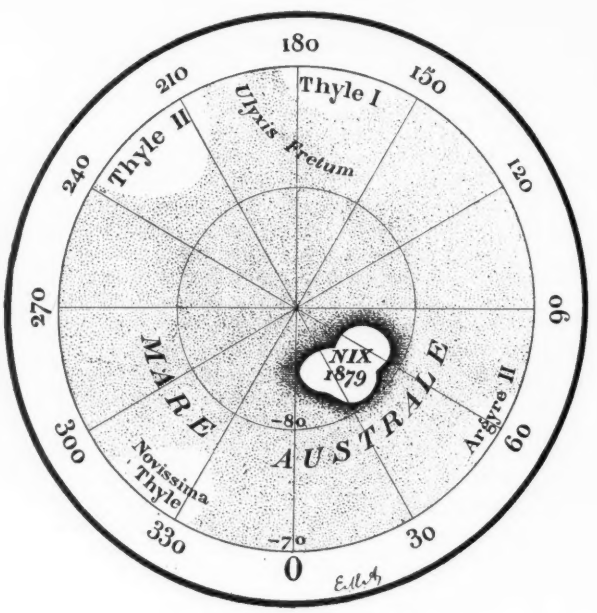
By E. M. ANTONIADI, F.R.A.S.



THE kindness of Monsieur E. M. Antoniadi enables us to meet the wishes of several of our correspondents who have asked for a chart of Mars brought up to date, and embodying the most trustworthy researches. The chart is based chiefly upon the works of Schiaparelli during the oppositions of from 1887 to 1890 inclusive, and upon the successive Reports of the Mars Section of the British Astronomical Association, together with M. Antoniadi's own long-continued observations.



North Polar Region of Mars.



South Polar Region of Mars.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

PERRINE'S COMET.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—The enclosed photograph of Perrine's comet was obtained with a $4\frac{1}{8}$-inch double combination Voigtländer of 15 inches focus, on 2nd October, at 9h. 50m. (mean) S. T., the exposure being for 30 minutes.

Cadett lightning plate with pyro metol developer was used, and the camera was attached to a $6\frac{1}{4}$-inch equatorial reflector, clock-driven.

Owing to the faintness of the nucleus, illumination of

the field was impossible, so that the comet could not be followed, but the driving had to be done upon δ Cephei, which was then a little *n. p.* the comet.

On the negative there are symptoms of a divided or fan-like tail, a feature which would be obscured to a great extent by the actual motion of the comet.

Owing to clouds, no opportunity has occurred of obtaining a further record.

Liverpool, October 7th. R. C. JOHNSON.

THE VISIBILITY OF THE CRESCENT OF VENUS.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—It is possible to present important evidence as to the visibility of Venus as a crescent many thousands of years before the invention of the telescope, from an archæological point of view, and that of such convincing character as to determine the question as to the early members of the human race, at any rate.

The planet Venus was the symbol, and associated star of, the great Babylonian, Phœnician, and Syrian goddess, Ishtar = Ashtoreth = Astarte; and one of the commonest attributes of this deity was a horned head-dress, and indeed she was known, as we find in the Old Testament and Phœnician and Carthaginian inscriptions, as "Astoreth-Karnaim," *i.e.*, "of the (2) horns," and had one or more temples of that name, probably placed upon a double-peaked mountain resembling the curve of a pair of horns.

Because of these attributes, and led astray by the statements of two late classical authors, Lucian and Herodian, many writers have termed her a lunar deity, but this is incorrect. She was undoubtedly considered by the Greeks as the counterpart of, or identical with Venus = Aphrodite. At the shrine of Aphrodite, at Afca, she was worshipped as a star. But we have much more decisive proof of Ashtoreth = Astarte being Venus, in that she was nothing else than the Aramaic, Phœnician, and Syrian form of Ishtar, the celebrated goddess of Babylon and Assyria.*

Ishtar undoubtedly was Venus, certainly not the moon, because at Babylon the Moon God was masculine; and the connection between the cult of Ishtar = Aphrodite = Venus as a voluptuous deity is well known.

There is in fact no straining of any of the evidence in stating that everything proves the horned Astarte = Ishtar = Astoreth-Karnaim to be the goddess personified by the planet Venus.†

What has to be accounted for is the universal acceptance of a crescent, or horns, for her most well-comprehended symbol. This, I think, can only have arisen from the crescent shape of Venus having been observed, and so properly associated with the deity. So much, indeed, did her symbol coincide with that of lunar deities, that when the true origin of the connection was forgotten, it caused the slight confusion we have mentioned in two of the later extant classics between Astarte and the Moon Goddess. In the clear air of Mesopotamia, no doubt it was possible to detect the phases of Venus, and so Ishtar = Venus = Astoreth-Karnaim is like many another early human concept, a reasonable expression of primitive symbolism.‡

JOSEPH OFFORD.

[I do not feel myself able to agree with Mr. Offord that the evidence which he presents as to the Babylonians having been aware of the phases of Venus is sufficiently convincing. It seems to me at least a plausible suggestion that the Babylonians saw some analogy between Venus and the Moon, and ascribed symbolically some of the Moon's attributes to her. It is not impossible even that they may have argued out the Copernican idea of the solar system, and consequently have deduced that Venus ought to show phases.

But if the Babylonians really observed the phases of Venus, and it can be shown that they did, I think we cannot escape the conclusion that they must have had telescopes. I believe the recognition of her crescent with the naked eye is entirely impossible.—E. WALTER MAUNDER.]

* The two divergent ideas associated with Astarte-Aphrodite, of gentleness and feminity with fierceness and heat, probably are connected with Venus as the morning star, goddess of the dew and of moisture and fertility, and as evening star, when the heat accumulated during the day and proceeding from the level rays of the setting sun is still so oppressive.

† A Babylonian cylinder, edited by Père Scheil, shows Ishtar as a cow, and recently some votive offerings of cows heads of an African type have been discovered in the Balearic Isles, no doubt from a Phœnician Ashtoreth shrine.

‡ In ancient Arabia Venus was a male god, no doubt connected with the Assyrian Sin, but strange to say the Arabs, or "Mineans," called him Athtar, apparently to secure the favours of both principals of the deity as worshipped by their kinsmen, by giving him the sex of the one form and the title of the other.

XUM

EXTINCTION OF QUAGGA.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I sent a skin of *Equus quagga* to Stevens' sale rooms, Covent Garden, for sale, about the time mentioned in the October number of KNOWLEDGE.

I thought it possible it was the skin bought by the Edinburgh Museum. If it is the same, I can correct the inference made by Mr. Renshaw that the quagga survived in the Orange Free State till about that date.

The specimen, as he suggests, was an old one. I brought it to England with other skins, horns, birds, and insects, in 1860, and kept it till the date of sale.

I once caught a young quagga alive. My waggon was outspanned near to a Dutchman's waggon; the Dutchman had been hunting quaggas, etc., and had scattered the herd of quaggas, and this young one was lost. We supposed it had followed the horses. It was here and there and everywhere round about the waggons and oxen. It was dark; we followed it by its cry, "Quag ha," and I caught it.

Marathon, THOS. COOPER.
6, The Avenue, Kew, Surrey,
October 3rd, 1902.

A MODERN TYCHO.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I should like to make a few remarks with reference to Mr. Maunder's comments on my letter *re* Jey Singh in your August number.

Mr. Maunder, I now understand, considers that Jey Singh's observations and methods are scarcely practical, and that the results he achieved could have been obtained with much less elaborate and costly instruments, and in a more simple manner. I cannot help thinking that he would modify this opinion if he had seen the Jeypore Observatory and had studied Jey Singh's works.

On his commencing astronomy, Jey Singh first made use of brass instruments fitted with sights, but he could not obtain accurate workmanship, and, after a short trial, he almost entirely gave up brass, and constructed large masonry instruments, in which there were no axes to wear out of truth, and in which, owing to their size, minute accuracy of workmanship and graduation were not required. Mr. Maunder states that he observed no special arrangements for fixing the position of the eye, but in one of Jey Singh's works, what is termed "an observation strip and tube" is described, and appears to be an arrangement for this very purpose.

Jey Singh determined latitude with the *bhitti yantra*, a large graduated stone circle, in the plane of the meridian, with which meridian altitudes were observed. This gave the angle for the inclined face of the gnomon. By placing the eye along the graduated edge of one of the quadrants, and watching the disappearance of the sun or a star behind the edge of the gnomon, hour angles or time could be obtained with great precision, surely with far greater accuracy than with a comparatively small sun-dial.

The circular buildings Mr. Maunder alludes to are at Jeypore, adapted for taking observations at all altitudes.

No doubt Jey Singh might have done excellent work with much simpler means, but he had the money to spend, and so preferred to build the best instruments he could. But before denouncing his methods as impractical, it should be remembered that minutely divided brass circles and turned axes were denied to him, and that he was consequently driven to strive after accuracy by increasing the size and stability of his instruments.

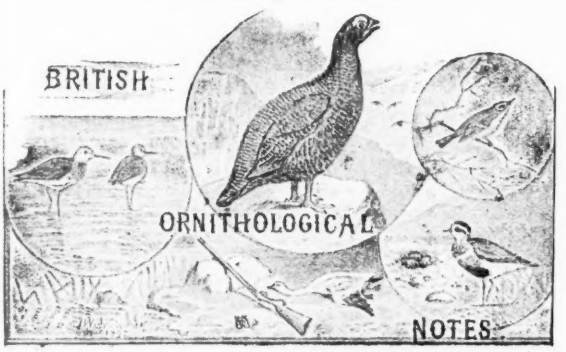
If I have the opportunity, I will make some observations as suggested by Mr. Maunder, but unfortunately most of the instruments have either been restored or completely reconstructed since Jey Singh's days.

A report on the Jeypore Observatory is in the press, and if Mr. Maunder would care to accept a copy, I shall be very pleased to send him one.

India, August, 1902. A. ff. GARRETT, Lt. R.E.

[I think Mr. Garrett has not quite grasped my point even yet. The erection of a huge stone instrument, gnomon, meridian circle, etc., means the *previous* determination of the meridian—in some cases of the latitude as well—with a precision greater rather than less than that shown by the building itself. In other words, the erection is in itself a demonstration that results more, not less, accurate were first of all secured by temporary instruments. A modern equatorial is set up approximately in the meridian and to the latitude of its station; but its accurate placing is secured later by the use of the optical power of the telescope itself in testing the effect of minute movements given to it by fine adjusting screws. There is no provision in the gnomon or circles at Delhi for a slow motion in azimuth, any more than there was for the Great Pyramid at Ghizeh. Then I cannot accept Jey Singh's complaint quite seriously as to the imperfection of his brass instruments, "the shaking and wearing of their axes, the displacement of the centre of the circles, and the shifting of the planes of the instruments." It seems to me that the wearing of the axis of a brass instrument could hardly have made itself apparent to the naked-eye observation in "a short time." Surely he could have got native metal-workers to do better than this if he had cared to try. We have plenty of evidence of their skill in the making of armour, etc. But I can quite understand that he may have had abundantly sufficient political and religious reasons for preferring the plan of solid buildings. The latter were, no doubt, an effective advertisement, and testified to his wealth, science, and religious zeal; whereas a few light instruments, seen only by the observers, would not have done so. Such reasons would be amply good enough to justify the course he adopted, but they would not be astronomical.

I am greatly obliged by Mr. Garrett's promise to make some practical observations with the Jeypore Observatory, and I shall most heartily appreciate the report on that observatory which he has kindly offered to send me. —E. WALTER MAUNDER.]



Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

THE BRITISH WHITE-FRONTED GEESE *(Anser albifrons, A. erythropus,* and *A. gambeli).*—Several ornithologists have been turning their attention lately to the geese which are to be found in Great Britain and Ireland. It is refreshing to find from their labours that there is still some systematic work to be done among British birds.

In the *Ibis* for April, 1902 (pp. 269-275), Mr. J. H. Gurney has a useful article on the three White-fronted Geese, *Anser albifrons*, *A. erythropus*, and *A. gambeli*; while in the *Zoologist* for September, 1902 (pp. 337-351), Mr. F. Coburn treats of the same three birds, with special remarks upon *A. gambeli*. Without entering minutely into the question, which would be out of place here, Messrs. Gurney and Coburn give fair evidence for their conclusion that these three geese are specifically distinct, and that they all occur in the British Islands. Briefly stated, *Anser albifrons* and *Anser erythropus* inhabit the greater part of Europe and Asia, but *A. albifrons* does not go so far north as its near ally. *A. albifrons* is the White-fronted Goose usually found in Great Britain, while *A. erythropus* was first noticed as a British bird in 1886, and has been procured but seldom since then in this country. *Anser erythropus* is a much smaller bird than *A. albifrons*, not only in its body but also in its beak, while its plumage is slightly darker, and the white of the face and forehead is more extended than that in *A. albifrons*. *Anser gambeli* is a North American species, and may be regarded as the New World representative of the White-fronted Geese. It is closely allied to *A. albifrons*, but may be distinguished from that species by its larger and heavier bill and darker under parts. Besides these differences Mr. Coburn has found that *A. gambeli* has a considerably longer neck than *A. albifrons*, a distinction which is made more valuable by his measurements having been made from birds in the flesh and not from skins. Mr. Coburn was the first to recognise that *Anser gambeli* is to be found in the British Islands. The first specimen which drew his attention to the subject was procured in Co. Mayo, and he has since found several others, but all, it appears, from Ireland. However, now that the differences between these three birds have been pointed out, specimens of the supposed *A. gambeli* may be found in many collections, and the question thus thoroughly examined. Mr. Coburn gives some valuable descriptions of the various changes of plumage in the two larger White-fronted Geese, but his dogmatic assertions as to how these changes are effected are supported by insufficient evidence.

THE BRITISH BEAN-GEESE.—Hitherto but two species of Bean-Geese have been recognized in the British Islands, viz., the Pink-footed Goose (*Anser brachyrhyncus*) and the Bean-Goose (*Anser segetum*). In the *Field* for October 4th, 1902 (p. 605), Mr. F. W. Frohawk describes how that in figuring the various European geese for M. Serge Alphéraky's work on the Geese of Russia, he has found that the true *A. segetum* is really very rarely found in this country, and that the bird which is usually so identified is in reality *Anser arvensis*. Mr. Frohawk does not give the range of the two species, but it appears that *A. arvensis* is by far the commoner bird in Europe and Asia. The two species differ apparently only in the bills. In *arvensis* the bill is slightly longer and straighter than that of *segetum*, while the "nail" of the bill is smaller in proportion and more rounded. In colour the bills of the two birds appear to differ markedly, that of *segetum* being black, with a band of orange between the "nail" and the nostrils, while that of *arvensis* is almost wholly orange-coloured on its upper portion, while the lower is about one-third orange and two-thirds black.

GLOSSY IBIS IN THE SCILLY ISLANDS AND IN HEREFORDSHIRE.—We have received two Glossy Ibis for preservation; one yesterday from the Scilly Isles, and another to-day from Herefordshire. We hear that there were two in the Scilly Isles, but only one obtained.—PRATT & SONS, Brighton, October 15th.

Cirl Bunting in Ireland. (*Zoologist*, September, 1902, p. 353.)—Mr. H. E. Howard here records that near Dunfanaghy, Co. Donegal, on August 2nd, he watched a Cirl Bunting (*Emberiza cirlus*) within a few yards. The Cirl Bunting has not been recorded hitherto in Ireland.

Observations on the Weights of Birds' Eggs. By N. H. Foster. (*Irish Naturalist*, October 1902, pp. 237-245.)—The weights and measurements of a number of eggs of 56 species of birds found in Co. Down, Ireland, are given here.

Increase in the Numbers of Breeding Birds in Mayo and Sligo. By Robert Warren. (*Irish Naturalist*, October, 1902, pp. 246-249.)—Mr. Warren here gives some interesting notes on the increase during the last few years of Starlings, Rooks, Blackbirds, Shovellers, Shelldrakes, Common Gulls, and Arctic and Lesser Terns in the counties mentioned.

Report on the Movements and Occurrence of Birds in Scotland during 1901. By T. G. Laidlaw. (*Annals of Scot. Nat. Hist*, pp. 66-82, 129-136, 193-199).—Mr. Laidlaw's annual report of the movements of birds in Scotland is always a careful and useful contribution.

Gulls killed while following the Plough. (*The Annals of Scottish Nat. Hist.*, October, 1902, p. 251.)—Mr. L. H. Irby records how that in the Island of Coll this spring four Common Gulls were killed or disabled while closely following a plough by the filth turned up by the plough falling back on them.

Starling Roost on Cramond Island. (*The Annals of Scott. Nat. Hist.*, Oct., 1902, p. 252.)—The Starling roost referred to in KNOWLEDGE for February last, page 35, is reported by Mr. Chas. Campbell to be now deserted. A good number of trees have been killed by the droppings of the birds, and the stench of the place is very disagreeable. Mr. Campbell thinks that the average length of time these birds occupy a particular roosting place in great numbers is five years.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at the Office of* KNOWLEDGE, 326, *High Holborn, London.*

ASTRONOMICAL.—There can be little doubt that the spectroscope will eventually give precise values of the rotation periods of the planets which have no surface markings sufficiently distinct for the application of the ordinary telescopic method, as it has already done for those parts of the sun which lie outside the spot zones, and for the rings of Saturn. M. Deslandres, of the Meudon Observatory, has given much attention to this work, and among his latest results is the determination that the rotation of the planet Uranus, like the revolution of the satellites, is in a retrograde direction. The method employed is to place the slit of the spectroscope along the equator of the planet, so that the rotation produces an inclination of the lines as compared with those given by a source of light which is at rest.

During the total eclipse of the sun, May 18, 1901, Mr. Perrine, of the Lick Observatory, took advantage of the opportunity of making a photographic search for an intra-Mercurial planet. After a minute examination of the negatives, he now reports that there is no planetary body as bright as 5·0 visual magnitude within 18° of the sun, whose orbit is not inclined more than $7\frac{1}{4}°$ to the plane of the sun's equator. Within two-thirds of this region it further appears that there was no such body as bright as $7\frac{3}{4}$ magnitude, unless at the time of eclipse such a body was in direct line with the sun or with the brightest part of the corona. Were there any considerable number of such bodies as bright as $7\frac{3}{4}$ magnitude it is probable that some would have been detected. A planetary body of this magnitude would be thirty-four miles in diameter. As seven hundred thousand bodies of this size, and as dense

as Mercury, would be required to produce the outstanding changes in the orbit of Mercury, it no longer seems possible to attribute these perturbations to bodies of considerable size between Mercury and the sun. It is not considered impossible, however, that the finely-divided matter composing the Zodiacal Light is sufficient in the aggregate to cause the recorded disturbances of Mercury's orbit.—A. F.

BOTANICAL.—The method of dispersal of the seeds of *Viola canina* are, perhaps, generally known through the observations of Kerner. When the capsule dehisces, the hard smooth seeds, which are attached to each of the three valves, are subjected to so much pressure by the contraction of the sides of the valves, that they are squeezed out and sometimes thrown to a distance of three feet. Mr. R. G. Leavitt has noticed the seed dispersal of another species, *V. rotundifolia*. In some instances, he states in *Rhodora* for September, the seeds are merely pushed out; many of them fall within a foot of the capsule that contained them; but others are thrown a distance of five feet, and he shows that in one case the distance reached, apparently by these means alone, was nine feet.

Monsieur C. De Candolle has published two papers on a curious Indian *Ficus*, remarkable in having all its leaves transformed into small pitchers. The second paper appears in the last number of the *Bulletin de l'Herbier Boissier*. Prof. Buchenau has recorded an instance of a pitcher-shaped leaf in the common fig (*Ficus Carica*), but this was merely accidental, and, as is usually the case, the inside of the pitcher was formed by the upper side of the leaf. In the plant investigated by Monsieur De Candolle the leaves appear to be normally pitcher-shaped, and the pitchers are extraordinary in having their interior formed by the under side of the leaf.

The botanical collections made during the visit of the Danish Expedition to Siam, in 1899–1900, have been investigated by various botanists, and the results are being published in the *Botanisk Tidsskrift*, in a series of papers edited by Dr. J. Schmidt. All the plants were obtained from Koh Chang and other smaller islands in the Gulf of Siam. The last part published (part 7) contains several new species of Dipterocarpaceæ, which have been described by Prof. Heim. Of the fourteen species enumerated no less than seven are new. This order appears to be exceptional with regard to the number of novelties, for on the whole the collections contain very few previously unknown plants. All the nineteen Compositæ brought from the islands are found in the eastern part of British India.—S. A. S.

ZOOLOGICAL.—In an article on four-horned sheep published in KNOWLEDGE for July, 1901, it was suggested that the duplication of the horns in those breeds was due to splitting of the normal pair. This suggestion has been made a practical certainty by a skull of a South African piebald ram recently presented to the British Museum by Mr. W. P. Pycraft. In this specimen each horn is cleft to within a short distance of its base; the minor branch, which is inferior in position, lying close alongside the larger. It may be added that the sheep of this breed, which appear to have come originally from Zululand, but have been introduced into many parts of Europe (inclusive of Great Britain), frequently develop two pairs of horns. These differ from those of the ordinary four-horned sheep of the Hebrides not only by their colour, which is black, but also in form.

From a bed of gravel near Greenhithe, Kent, known, on account of the number of shells of that genus it contains, as the Neritina-bed, Mr. E. P. Newton, in the September number of the *Geological Magazine*, describes a large rodent incisor which he believes to be referable to the giant beaver (*Trogontherium cuvieri*). Hitherto remains of that species have been known only from the Norfolk forest-bed. If the present specimen be correctly identified, it tends to show that the latter deposit is of Pleistocene, and not, as supposed by some, of Pliocene age.

In the *Annals and Magazine of Natural History* for September, Mr. O. Thomas describes from Szechuen a larger form of that beautifully coloured animal the panda, or cat-bear, of the Himalaya, under the appropriate name of *Ælurus fulgens styani*, bestowed in honour of Mr. Styan, who has done so much to increase our knowledge of the fauna of North-Western China.

An even more interesting animal is described in the October issue of the same journal by Mr. Thomas. This is the eastern form of that large and handsome antelope commonly known as the bongo (*Tragelaphus euryceros*), the first skin of which to be received in this country was obtained by M. du Chaillu on the West Coast. Of the eastern representative of this antelope a fine series of skins and horns from the forest district to the eastward of the Victoria Nyanza have recently been presented to the Natural History Museum by Mr. F. W. Isaac. These specimens show that, in the eastern race at any rate, the bongo differs from its cousins the bushbucks in that the females as well as the males carry horns. This necessitates the reference of the former animal to a distinct genus, which it is proposed to call *Böocercus*, in allusion to the tufted, ox-like tail. Since the eastern race differs somewhat in the horns and skull from the typical western form, Mr. Thomas designates it *B. euryceros isaaci*. It is a remarkable circumstance that the elands and bongos, the two representatives of the tragelaphine antelopes with horns in both sexes, also differ from their relatives in having tufted, in place of fully haired, tails.

In the same number Mr. R. I. Pocock publishes a revised classification of the existing members of the horse family. After assenting to the view that the Asiatic members of the family, namely, Przewalski's horse, the domesticated horse, and the kiang, or chiggetai, form a group by themselves, the author points out that the North African wild ass and the mountain zebra of South and South-West Africa are very closely related to one another. Burchell's zebra and its subspecies, on the other hand, come so close to the true quagga (whose name they have usurped) that Mr. Pocock regards the whole series as local variations of a single species, for which the name *Equus quagga* stands. Very distinct from all the rest, in the author's opinion, is Grévy's zebra, of Abyssinia and South Somaliland. From this it will be gathered that Mr. Pocock attaches little or no importance to the presence or absence of striping in this group as indicative of affinity.

The discovery of a new vertebrate fauna of Middle Cretaceous age in the north-west territories of Canada is a circumstance of more than ordinary interest, especially since among the remains are teeth of two species of mammals. The new fauna, so far as it is at present known, is described by Messrs. Osborne and Lambe in *Contributions to Canadian Palæontology* (Vol. III., pt. 2); Professor Osborne dealing with its general characters and relations, and Mr. Lambe discussing the genera and species. The reptiles include several chelonians and dinosaurs; among the latter being a species of *Trachodon* (a relative of the iguanodon, but with pavement-like teeth), of which the impression of a portion of the skin

is preserved in the matrix. The best of the two mammalian specimens belongs to a form nearly allied to the little *Plagiaulax* of the Dorsetshire Purbeck, a species ever memorable on account of the controversy which took place as to whether it was herbivorous or carnivorous.

Notices of Books.

"ANIMAL FORMS: A SECOND BOOK OF ZOOLOGY." By D. S. Jordan and H. Heath. (London: Hirschfeld.) Pp. vii. + 258. Illustrated.—If American writers intend to make a serious attempt to capture the English market for zoological text-books, they would do well to see that their work is suited to its environment. In a volume bearing only the name of an English publisher, and betraying to those unacquainted with the nationality of its authors no indication of its trans-Atlantic origin, save certain peculiarities of orthography and diction, it is nothing short of absurd to find that the expression "this country" means North America. For example, the student is likely to be puzzled by the statement on page 241 that "in this country the group [of cats] is represented by the lynx (*Lynx canadensis*), the wildcat (*L. rufus*), and the panther or puma (*Felis concolor*)." Neither is the sentence (p. 239) that "the native hollow-horned ruminants (*Bovidæ*) are at present confined to the western plains, and comprise the prong-horned antelope, the wary bighorn or Rocky Mountain sheep, and the bison or buffalo," calculated to make matters clear to the mind of the average English reader. We might, moreover, take exception to the last sentence on the ground that the pronghorn is not generally regarded as a member of the *Bovidæ*. A further objection we venture to make is the employment of American misnomers in a work professedly English, as exemplified by the title "American elk" to the plate of Rocky Mountain wapiti. If it is worth while to publish an American work in a professedly English guise, the least the authors can do is to prepare an edition specially revised for the new field. As regards the character of the work itself, we are glad to be able to express a favourable opinion, the descriptions of the various groups being couched in language easy to be understood by the beginner, and the illustrations admirable in character and in execution. Especially striking and original is the figure of a group of lamp-shells on page 69, where the artist, by the ingenious introduction of a cliff of carboniferous strata, has been enabled to show the members of an extinct family alongside their living representatives. The classification adopted is in the main well up to date, and the use of technical terms avoided as much as possible. We are, however, somewhat surprised to see the lancelet included among the fishes, instead of with the protochordates; and we are still more astonished at the statement (p. 231) that "the duck-moles are the only mammals which lay eggs." So far as we are aware, it is only the spiny anteaters that are definitely known by ocular evidence to lay eggs; and it is commonly asserted that the duck-mole produces a pair of young annually (presumably in the form of eggs), and not a single one, as stated by the authors. If revised on the lines pointed out above, the volume before us may lay claim to a share of patronage by English students.

"WEBSTER'S INTERNATIONAL DICTIONARY." A new edition with Supplement. (George Bell and Sons.)—If we refrain from declaring this magnificent work to be the best dictionary, it is only because we do not work habitually with Webster; but we entirely agree with the late Lord Pauncefote in his appreciation of the extraordinary learning and industry which have been bestowed upon the work. Its American origin is, of course, a disadvantage to it among English students and litterateurs, but it is a work of the utmost practical utility, and is certainly among the best working dictionaries of the English language.

"THE ELEMENTARY PRINCIPLES OF CHEMISTRY." By Prof. A. V. E. Young. Pp. xiv. + 252 + 106. (Hirschfeld Bros., Limited.) Illustrated. 5s. net. "ELEMENTS OF PHYSICS." By Dr. C. H. Henderson and Prof. J. F. Woodhull. Pp. x. + 388 + 112. (Hirschfeld Bros., Limited.) Illustrated. 5s. net.—These two volumes belong to a series of Twentieth Century Text Books, designed to meet the demand for short treatises written from the point of view of modern science in literary style, accurate diction, and laboratory mood. The aims are high, but they are true; and though it would be too much to say that the authors have been completely successful, yet their books are well worth the attention of teachers and students. Each book consists of a theoretical or descriptive part, and a second part, with separate pagination and index, containing details for illustrative experiments in laboratory and lecture room. Full-page portraits are given of distinguished men who have contributed to the progress of science, and the illustrations of apparatus are in most cases admirably done.

Prof. Young has produced an inspiring and philosophical work, which should be of real assistance to students of chemistry. Beginning with general considerations as to properties of bodies of practical importance, he passes to fundamental laws of chemical action, equivalent and combining weights, the atomic theory, and then the chief elements and their compounds, taken collectively and separately. The experimental work referring to points in the text is of an instructive character, and the hints on the manipulation of apparatus and materials will be found useful. The separation of the experiments from the descriptive text has the advantage of permitting an unbroken argument to be stated, but there are some objections to it when the text is made to depend upon the students' experiments. A better plan is to make the text a didactic statement of experience, to be read by the student before or after he has done his practical work, but not actually depending upon his results. In the example of a record from a laboratory note-book, given on page 103, two long division sums and one multiplication are worked out. Students who use a book of the type of Prof. Young's ought not, however, to do sums in this way, but by the use of logarithms. But these are minor points, and do not prevent the book from containing as good a survey of chemical science and philosophy as it is possible to give within its limits.

The text-book of physics by Drs. Henderson and Woodhull is more of the conventional type than Prof. Young's volume; in fact, we have found little to distinguish it from other manuals of physics, either in scope or treatment. Three kinds of levers are classified, though the division is quite unnecessary; the wave theory of light does not receive sufficient attention; no experimental method by which the velocity of light has been determined is described, and most of the matter is of a very elementary character, though this is partly accounted for by the extent of the subject. The standard of the work is about that of first and second year students in schools of science, or the junior division of the Oxford and Cambridge Universities' Local Examinations. For such students the descriptive text and experimental course would be found very suitable.

"EUROPEAN FUNGUS FLORA: AGARICACEÆ." By George Massee. (Duckworth.) 6s. net.—In a single volume of handy size, Mr. Massee lists and describes the Agarics of Europe. To accomplish this task in 280 pages requires a large amount of condensation, and hence we find the description of each species occupying on the average but three lines, essential characters only being mentioned. No attempt is made to indicate the range of the species, except that non-British plants are enclosed in brackets. As a key to this great group of fungi Mr. Massee's work will be of much value, while the author's name will carry with it confidence in the critical worth of the work. It is somewhat discouraging to the beginner at British Agarics to learn that the foreign species mostly fit in between the British ones, when the difficulty of discriminating between many of our native species is remembered. Altogether 2750 species are described, of which 1553 are known to occur in Britain—a considerably greater number, Mr. Massee remarks, than is at present on record from any other European country. A useful Bibliography of more recent and important works is appended; under Great Britain it is strange to find no mention of Stevenson's *Hymenomycetes*, the most important British book on the subject. There is a full index of species, and the book is excellently printed and neatly bound.

WE have received from Messrs. Erdmann & Schanz one of their "Triumph" Aluminium Stereoscopes, together with a selection of stereo slides, representative of some of the several series catalogued by this well-known house.

BOOKS RECEIVED.

Kathlamet Texts. By Franz Boas. (Smithsonian Institution.)

Niels Henrik Abel Memorial Public a L'occasion du Centenaire de sa Naissance. (Williams & Norgate.) 21s. net.

The Cat Manual. By Dick Whittington. (Newnes.) 1s. 6d. net.

Science Teacher's Pocket Book and Diary, 1902-3. (Woolley.) 1s.

XUM

How to Buy a Camera. By H. C. Shelley. (Newnes.) Illustrated. 1s. 6d. net.

Art of Extempore Speaking. By Harold Ford, M.A., LL.D., D.C.L. Third Edition. (Elliot Stock.) 2s. 6d. net.

Junior Chemistry. By E. A. Tyler, B.A. (Methuen.) Illustrated. 2s. 6d.

Birds in the Garden. By Granville Sharp, M.A. (Dent.) Illustrated. 7s. 6d. net.

Explanations of Terms and Phrases in English History. By W. T. S. Hewett, B.A.LOND., D.C.L. (Elliot Stock.) 1s. 6d. net.

Manners and Customs of the Modern Egyptians. By Edward William Lane. (Ward, Lock.) Illustrated. 2s.

Hydrographical Tables. Edited by Martin Knudsen. (Williams & Norgate.) 5s. net.

Flora of the East Riding of Yorkshire. By Jas. Fraser Robinson. To which is added a *List of the Mosses of the Riding.* By J. J. Marshall. (A. Brown & Sons, Ltd.) 7s. 6d.

List of Observations. (Smithsonian Institution.)

Journal of the Society of Comparative Legislation. (Murray.) 5s.

Royal Astronomical Society's Reprints, Nos. 45, 48, 54 to 63, and 65.

Meteorological Observations at the Royal Institution of Cornwall, 1850-1900. Compiled by George Penrose.

Commercial Supremacy and Military Service. By Sir James Blyth, Bart.

Penny Chronology. Third Edition. By William Thynne Lynn, B.A., F.R.A.S. (Sampson Low.)

Literature and Dogma. By Matthew Arnold. (Watts & Co.) 6d.

INSECT ODDITIES.—II.

By E. A. BUTLER, B.A., B.SC.

In our last paper, some of the oddities of insect life were selected from that single order which is so prolific in queer creatures, viz., the Hemiptera. In the present one, our selection will be made from the rest of the insect world, so far as it is represented in the British Isles. But before entering upon the description of these additional oddities, it may be worth while to point out that another very excellent example would have been taken from the order Hemiptera, had it not been already dealt with in a previous number of KNOWLEDGE. If the reader will turn to Vol. XVII., p. 148, he will there find a short account of the insect called *Orthezia urticæ*, a fairly common species belonging to the so-called scale-insects, and one which, at least in the female sex, looks more like a piece of sculpture in alabaster, or a cast in plaster of Paris, than a living insect, and it is well worthy of a place in our gallery of oddities.

Turning now to the order Hymenoptera, that of the bees, wasps and ants, we will select a curious creature belonging to a small section of the order called *Proctotrupidæ*. This section contains the smallest of all Hymenopterous insects, many of which are so minute that they are able to spend their whole larval life within the *eggs* of other insects, finding in the contents of a single egg sufficient food to last them their lifetime. The insect we select, however, is much larger than this, though it also is a parasite. It is called *Gonatopus pedestris* (Fig. 1), and its place here, at the head of the present paper, is a most appropriate one, as it is parasitic upon insects of that group which yielded most of the illustrations in the former paper.

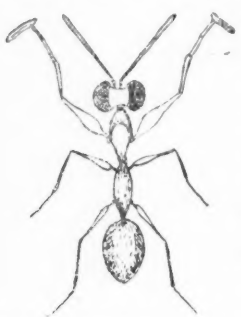


FIG. 1.—*Gonatopus pedestris.*

If we find in August or September a field in which the herbage has been allowed to grow long and dry, and sweep with a net amongst the long grass-stalks, we shall probably capture hundreds of small brownish or yellowish frog-hoppers, belonging chiefly to the two genera *Athysanus* and *Deltocephalus*, the former being the larger of the two. Amongst this crowd of jumping creatures, we shall probably notice a few individuals which seem more or less deformed. They are incommoded by having a large black wen-like excrescence growing from some part of the body, generally the fore-parts, and especially at the side of the head, at the junction between it and the thorax (Fig. 2). By this we know that the insect is suffering from the attack of a parasite which is either our *Gonatopus*, or something akin to it. The black excrescence is, in fact, a sort of case which contains inside it the grub of the parasite. The juices of the host are diverted from their true course to pass through the slender attachment of this black bag to the body, and so to nourish the larva contained within it.

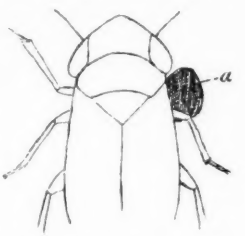


FIG. 2. — Fore-parts of *Athysanus obsoletus*, with parasite (*a*).

The case is something like an oval box constructed in two parts, which unite together all round the edge. The larva within is a footless maggot, which has a very easy time of it, being fed entirely at the expense of its host, while it has nothing to do but lie still and enjoy itself. When it is full grown the black skin bursts, the lid coming off as it were, and the imprisoned insect escapes, and soon spins a little cocoon somewhere in the neighbourhood. From this cocoon emerges in due time a most odd-looking creature (Fig. 1), something like an ant in general appearance, but with a disproportionately large head, and a most extraordinary pair of fore-legs. A large part of the head is occupied by the huge masses of the compound eyes. The thorax is greatly elongated, chiefly in consequence of the large size of its first segment, the prothorax, which is much more fully developed than is usually the case in this order of insects. There is nothing remarkable about the body, nor about the two hind pair of legs, save that they are rather long and thin, and that their thighs are clubbed. But it is the fore-legs that constitute the most important part of the creature's anatomy, for upon their skilful manipulation depends the solution of the question whether the insect shall be able to secure for itself a posterity, or whether its line is to become extinct with itself. Of course, it is the female insect we are referring to throughout.

To provide for the deposition of its eggs, it will have to catch a suitable froghopper, and every entomologist knows that this is one of the most difficult tasks to which he can be set, for of all insects the froghoppers are the most agile and the most wary; their awkward habit of suddenly kicking out with their hind legs, and so jerking themselves violently through the air from place to place, makes them the most tantalizing of objects to hunt. To meet the difficulties of the situation, therefore, we find that *Gonatopus* is doubly well equipped. In the first place, there are those huge masses of eyes on each side of the head, by which a wide horizon can be scanned, and a good look-out kept for the discovery of a suitable quarry. And then there are the fore-legs, which are a *multum in parvo*, and remind one of those household implements which are many tools in one—hammer, screw-driver, pincers, and the like. The leg is not merely a walking machine. It has an extra thick thigh, which means good muscles for the rapid and forceful movement of the whole limb.

Then comes the long and thin shank, which is succeeded by a foot, the like of which we may search for elsewhere in vain. Instead of the pair of claws by which an insect's foot is usually terminated, there is an apparatus proportionately very large and most awkward looking, and reminding one of a boy's clasp knife (Fig. 3). Being in reality a modified pair of claws, it consists of two parts, one of which is broader, turned up at the tip, and furnished with stiff bristles along its inner edge, and this corresponds to the hasp of the knife; the other is thin, blade-like and pointed, and represents the blade. The claw-like blade can be opened out fully so as to be in a line with the stouter hasp, or it can be completely closed upon the latter just as the blade upon the hasp. The whole apparatus is attached to the rest of the foot at the hinge where its two parts move upon one another, and, therefore, though symmetrically disposed with regard to the foot when open, it hangs down on one side when closed, and gives a most unsymmetrical and malformed appearance to the limb. This curious apparatus acts as a pair of pincers, and its function is evidently to seize hold of the bristle-like hairs of some froghopper less wary than usual, so that it may be detained to serve as a host for the egg of the parasite. It can hardly seize anything much larger than the hairs of its quarry, as the whole apparatus is so minute that a microscope is necessary in order to make out its details.

For our next oddities we will go to the order Diptera, or two-winged flies. There is a certain section of this order the members of which are external parasites on warm-blooded vertebrates, and as habits of this kind often produce great modification in the form of the parasite, we need not be surprised that some of the insects referred to are so changed as to be scarcely recognisable as flies. They are generally flat-bodied, shiny creatures, with bristles scattered over the body, and with stout legs ending in strongly curved and very powerful claws. The single pair of wings which distinguish dipterous insects are usually present, though often greatly modified in form; but sometimes they are altogether absent, and the insect is quite apterous, so that none but an expert would suspect its near relationship to the active and vivacious flies.

FIG. 3. — Claws of *Goniopus pedestris*. Highly magnified.

Our first example may be the "bird-fly," *Ornithomyia avicularia*, which is a parasite on birds, and sucks their blood in much the same way as the bed-bug does that of humankind. This insect shows very well the flattened head and thorax which are so common in the group; its wings are ample and it can fly well. The claws are large in proportion to the size of the body, and they are very powerful and permanently bent abruptly inwards, reminding one of the corresponding structure amongst vertebrates in the hand or foot of a sloth. The claw of an allied insect is shown at Fig. 5A. This arrangement, while it unfits the insects for walking easily on flat surfaces, gives them a wonderful tenacity of grip on uneven surfaces, and makes it difficult to dislodge them from the feathers of the birds on which they live. They are very vivacious insects, running with great agility, often sideways like a crab, and easily eluding pursuit by burying themselves in the feathers of their host. These parasitic flies, though exhibiting the habits of lice, must not be confounded with the true bird-lice, which are very different and much smaller insects, apterous and constituting a distinct order called Mallophaga.

A rather larger insect, somewhat similar to the bird-fly, but with dark shiny brown body, attacks horses in the same way, and is sometimes exceedingly troublesome to them. In accordance with its habits, it is called *Hippobosca equina*. It has a very tough body which can stand a great amount of pressure without being harmed—a very useful attribute when one thinks of the risks it must often run in getting into narrow corners, under harness, &c. The head of this insect is worth a careful examination under the microscope, as it shows the sort of structure an insect often takes on in becoming parasitic. Everything is arranged with a view to the least resistance in passing amongst the hairs of the animals on whose blood it feeds. The surface of the skin is very polished and well rounded, without prominences which might get in the way. The outline of the head is continued in the eyes, and the antennæ are neatly disposed of by being sunk in a couple of pits. They usually stand out prominently on a fly's head, and if that were so in the present case, they would no doubt be an impediment to rapid progress amongst a forest of hairs. But they are much shortened and consist mainly of a large round knob, surmounted by a long and strong black bristle, which is the only part visible outside, all the rest being sunk in the pit. It is curious that an exactly similar contrivance may be found in another parasite, though a very dissimilar one, viz., the common flea. Between the antennæ, and at a little lower level, is a sort of black beak which ensheaths the piercing apparatus. This latter contains bristles strong enough to penetrate even the tough hide of a horse, and thereby cause intense irritation.

The swallow louse, *Stenopteryx hirundinis* (Fig. 4), is another of these parasitic flies. It has the same flattened and polished body, and the same stout legs and curved claws, the former green and the latter black, as usual. But it has advanced a stage on the road to the apterous condition; the wings are reduced very much in breadth, and look as if all the inner parts had been cut away with a pair of scissors, only the outer and stronger edge being left. The creature lives parasitically upon swallows, making its way, crab fashion, amongst the feathers till it reaches the skin, which it pierces with its beak for the sake of the blood. If the host dies, the fly is not long in discovering the fact, and it forsakes the now useless body, flying away till it encounters some other living being on which to alight and try the strength of its beak. If this does not happen to be a bird, the fly soon leaves it and proceeds on its travels till a more suitable host is discovered. When thus free, it is sometimes troublesome to human beings. The Rev. W. Kirby mentions a case in which one of these creatures behaved just like a bed-bug, establishing itself in a bed and greatly worrying the occupant for several nights without his suspecting the true nature of the annoyance, till at last a close and careful search brought the culprit to light. Curiously enough, when I had reached this point in writing this paper, a living specimen of this same fly was brought me, which had settled upon a person walking by the side of a wood, and had startled him by its quaint form and strange motions, so that he captured it at once.

FIG. 4. – Swallow louse (*Stenopteryx hirundinis*).

This swallow louse, as mentioned above, has got its wings abbreviated, and it seems likely that in the course of time its descendants may have theirs still further

reduced, and may ultimately lose them altogether. Such a stage has, in fact, already been reached by one member of the group, which has thus lost all resemblance to a fly, and, in fact, is popularly regarded as hardly even an insect, being called the sheep-tick (Fig. 5). This name, however, is a misnomer, as the true ticks are parasitic mites, eight-legged creatures belonging to the class Arachnida, which includes spiders and scorpions. The sheep-tick is six-legged, and is, of course, a true insect, being, in fact, merely a much modified fly. Its scientific name is *Melophagus ovinus*. It is a most repulsive-looking creature of a dark brown colour, about three-sixteenths of an inch long, and is a common pest of sheep, to the fleece of which it clings with extraordinary tenacity so as to be difficult to remove, while, at the same time, it is able readily to work its way hither and thither amongst the compact mass of hairs and so elude pursuit. It has

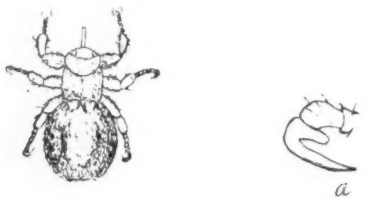


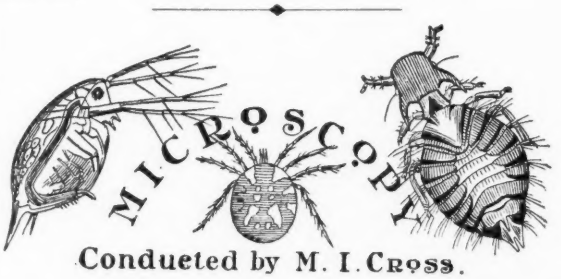
Fig. 5.—Sheep-tick (*Melophagus ovinus*); *a*, claw of ditto, much magnified.

absolutely no wings, and at first sight it appears to have no head; but this is because the head is completely sunk in the thorax, so that there is no constriction between the two, nothing in the nature of a neck. In this feature it departs very widely from the normal plan of fly structure. The head of a fly is usually attached to the body by so slight and narrow a junction, that it can be partially revolved round its pivot from side to side, and a mere jarring is sometimes enough to decapitate a dried specimen; this the dipterist often finds out to his cost, for a collection of flies, unless most carefully kept, is pretty sure to suffer more or less loss from the accidental decapitation of specimens. But no such calamity could ever befall a sheep-tick.

As in all these "louse-flies," the abdomen looks like a more or less flattened bag and shows no trace of segmentation, and its peculiar construction is associated with one of the most remarkable characteristics of these in other respects equally extraordinary creatures. There are several members of the order Diptera, such as the flesh flies for example, that retain their eggs long enough within the parent's body for them to hatch, and hence the young are produced in the form of maggots. But this sheep-tick, as well as the other louse-flies already described, carries this peculiarity still further, and the birth of the young is delayed, not merely till they cease to be eggs and are hatched into maggots, but even until they have passed through their whole larval life and are just on the point of becoming pupæ. While within the maternal body these larvæ are nourished by a sort of milky secretion furnished by the parent. The so-called eggs that the fly produces, therefore, are not really eggs at all, but consist of what in flies is called a "puparium," *i.e.*, a case composed of the last larval skin, containing within it the true pupa or chrysalis. These pupæ are of course very large, and one of them is enough to occupy all the available space in the fly's body, and therefore, necessarily, at each birth the insect's progeny is restricted to a single individual. Of course, the size of these so-called "eggs" would alone be sufficient indication that when thus named they are miscalled. From the peculiar method of their reproduction, this particular group of flies is sometimes called the Pupipara, or pupa-producers.

It might have been supposed that in the sheep-tick these parasitic Diptera had reached the lowest depth of degradation and achieved the maximum of modification, but such is not the case; there are other species that exhibit a still more modified and degraded form, and are thus still more unlike what one ordinarily understands by the word "fly." First there are the so-called Spider-flies or Bat-lice, belonging to the genus *Nycteribia*. They are little creatures, only about $\frac{1}{8}$ of an inch long, of very active and agile habits, living parasitically on bats. The head is reduced to a rudimentary condition, and what little there is left of it is sunk deeply in the thorax, so that the insect appears to begin with its first pair of legs. They are quite wingless and look more like small spiders than flies. Still smaller, more rudimentary, and less fly-like is the little *Braula*, or bee-louse, a parasite on bees.

From what has been said above, it will incidentally have become manifest that vertebrate animals are subject to the attacks of at least six distinct sets of parasites of quite different types, the popular names for which are more or less confused, and do not always truly represent the zoological position of the animals, so that such words as lice, ticks, &c., by themselves are but vague, and convey little more distinct idea than that of parasitism. Best known are the fleas, an aberrant group of dipterous insects, and the bugs, belonging to the Hemiptera. Then there are the true lice, with suctorial mouth, which may perhaps be regarded as degraded Hemiptera; the true bird-lice, or Mallophaga, with biting mouths; the Pupipara, or so-called spider-flies, bird-flies, bird-lice, bat-lice, or louse-flies, a parasitic section of the Diptera; and lastly the ticks, or *Ixodidæ*, which are not insects at all, but are allied to the mites and spiders in the class Arachnida. Even these six groups do not exhaust the list of those persecutors of vertebrate animals that actually take up their residence upon the bodies of their victims, though they are all that happen to have occurred to us in our investigations thus far.



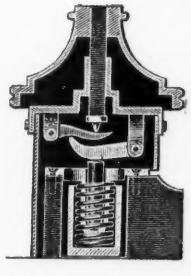
Conducted by M. I. Cross.

Pond-life Collecting in November.—With the advent of November, Pond-life all round becomes less abundant, and fewer species are to be met with. By degrees many of the water-plants die down, and the fauna is reduced to such forms as can subsist through the winter. Those animals which cannot do this, such as Polyzoa, Daphnia, some Rotifera, etc., have by this time produced so-called winter eggs or resting germs. The winter fauna, however, is much more numerous than is usually assumed. Among Rotifers, several species of *Synchæta*, *S. pectinata*, *tremula* and *oblonga*, seem to like the winter quite as well as the summer; then the following may also be expected in moderate numbers: *Asplanchna priodonta*, *Anuræa aculeata*, *Polyarthra platyptera*, *Rotifer vulgaris*, *Euchlanis deflexa*, *Triarthra longiseta*, *Brachionus angularis*, *Conochilus unicornis*, *Diglena forcipata*, *Diaschiza lacinulata* and *ramphigera*, *Dinocharis tetractis*, and others. Among the Infusoria, the Vorticella in particular seem to like the cold season, and a number of different species, and often large colonies, can be found attached

to submerged rootlets of trees growing near the edge of the water. Attached to the fine stems of *Carchesium*, *Zoothamnium* and other stalked colonies of Vorticella, the very much more minute, but beautiful, colonies of Collared Monads: *Codosiga*, etc., are often found, and deserve a good look with the higher powers.

In canals and lakes where Cristatella has been abundant during the summer, their spiny stadoblast may now be found liberated and often in large masses floating near the edge of the water which lies opposite to the direction of the prevailing wind. These should be collected and placed in a jar full of water with some Anacharis in the warm room at home, where they will hatch by the end of December or January, and the beautiful young Polyzoa can be seen emerging from their box-shaped prison.

FINE ADJUSTMENTS.—In a former number (July, 1901) some fine adjustments of recent construction were described, and reference was made to one which Messrs. Swift & Son were introducing, the details of which, at the time, were not ready for publication.



The adjoining figure will enable the principles of its construction to be at once appreciated, its action depending on a lever of the second order, which communicates an exceedingly slow rate of movement, and at the same time allows of the use of a coarse operating screw, which obviously would not be so liable to wear with constant use as a fine one.

A fine adjustment of this description goes a long way to elevating a microscope from a tool which magnifies to an instrument of precision, and is a feature which, there is no doubt, will bring its proper reward to its inventors.

While on the subject of fine adjustments, a new two-speed arrangement may be incidentally referred to. Descriptions have previously appeared in these columns of the original device which was introduced by Messrs. R. & J. Beck, and now an altogether different one, possessing novel features, has been put on the market by Messrs. W. Watson & Sons.

In Messrs. Beck's form, the two milled heads were mounted on one centre, *i.e.*, one operated through the other; in Messrs. Watson's form their ordinary lever is used, and for the extra slow movement a second lever is joined to the main one, and acts in conjunction with it, a second milled head separately mounted being fitted for effecting the movement. In effect, the operation of the second lever is the same as an extra long lever would produce.

Considerable limits in the rate of movement are possible by merely altering the pitch of the thread or the point of contact with the lever. In any case it is worthy of notice as a new device in microscopic adjustments.

CELLULAR STRUCTURE.—The interest and information which arise from the examination of cell structures and contents is such as to make it worth while for the ordinary worker to pursue the subject in some degree for himself. Who has not been struck on examining chlorophyll or protoplasmic structure for the first time? and the interest is materially increased by the knowledge of the controversies which have occurred, and experiments which have been made for so many years in connection with this particular subject.

A simple method of examining for oneself is as follows: Take an onion, cut it in half and separate the layers with a pair of forceps; clinging to each scale is a delicate vegetable membrane. This is carefully removed and a piece cut from it with a pair of scissors, about $\frac{3}{8}$ of an inch diameter. This will then have to go through a fixative of 30 per cent. alcohol, in which it is immersed for about three minutes. The fixed specimen is then transferred to a 1 per cent. watery solution of iodine for five minutes. This stains the nucleoli, nuclei, protoplasm and cell-walls a yellow or brown. The specimen is subsequently rinsed and mounted.

If the protoplasm in the cell is to be the special object of examination, some of the fixed pieces should be placed for five minutes in an 80 per cent. solution of alcohol, then transferred to a 1 per cent. aqueous solution of methyl violet for three minutes. This will produce a violet staining effect, which will show not only the cell-wall, nucleus and nucleolus, but also the protoplasm as a distinct mass with a clear space between it and the cell-wall.

If it is desired to double stain the sections, they should be transferred from the fixing solution to Delafield's hæmatoxylin for ten minutes, rinsed in water, then placed in hydrochloric acid 10 drops, water 100cc., in which they should remain until they fade to a salmon pink colour; transfer to water until they assume a light blue colour, immerse in a 1 per cent. aqueous solution of eosin for $\frac{1}{2}$ minute, rinse and mount. These processes produce a nucleus stained a rich blue and other structures pink.

The subject may also be examined fresh in water on a slide having an excavated centre, when the nuclei and cell-walls will appear in faint outline.

WANTED, A MICROSCOPE TABLE.—There are a large number of working microscopists who are greatly restricted for space, and are consequently unable to devote a room for their work, or even to have many really essential fittings. To such, a table which would at once combine and afford all the convenience for microscopical work would be a boon. Medical men nowadays especially have frequently to prepare specimens of sputum and other micro. subjects for immediate examination, and, under ordinary circumstances, each individual item of the various processes has to be specially looked out, the microscope set up and arranged, all at the cost of considerable time and trouble.

Many amateur microscopists would work a great deal more with their instruments if it were not for the trouble of having to look everything out and prepare it for working, this alone often occupies as long or longer than the time at disposal for actual work.

What is wanted, therefore, is a table which shall permit of the microscope being left in readiness for work, and so arranged that either daylight or artificial light may be immediately available. There should be suitable drawers or fittings for lenses, condensers and micro. accessories; proper fittings for re-agents, wash-bottles, troughs, etc.; drawers for mounted specimens, and in addition a space which shall be dust-proof, but not air-proof. In addition, if some convenient device could be suggested for having a supply of water, together with a small basin or sink, the convenience would be increased.

It may be that many readers have given thought to such a matter as this, or may be disposed to do so. I should be glad to receive suggestions or drawings of a comprehensive table, and would arrange that two or three were published in these columns.

Seeing that photo-micrography has now become so much a part of a microscopist's equipment, the desirability of including space for a camera, etc., in connection with the table might also be considered.

COVERS FOR MICRO. SPECIMENS, ETC.—I am indebted to a reader for kindly sending to me a sample of a very neat cover, which would, I believe, be found advantageous to many working microscopists. This particular one is sufficient in size to cover a 3 by 1-inch slip, and is of the kind used by watch-makers for protecting their work; larger and smaller sizes can be obtained.

In the workroom one is constantly wanting something of the kind for protecting watch glasses, dissecting dishes, staining cells, and preparations generally; this would just seem to meet the need. It has the special advantage of being ornamental as well as useful, the handle being of cut glass of very neat design.

The sender of this states that this was obtained from a wholesale watchmaker in Clerkenwell.

NOTES AND QUERIES.

C. S. T.—The most likely people to give you information as to the various materials for grinding rocks are Messrs. Cotton & Johnson, 14, Gerrard Street, Soho, W. Have you tried Carborundrum?

W. P. B.—The best book on the microscope is "The Microscope and its Revelations," edited by Dr. Dallinger, of which a new edition has recently been published. Of the simpler and more elementary works, "A Popular Handbook to the Microscope," by Lewis Wright, costing 2s. 6d., is very good. To use your Student's Petrological Microscope for general purposes, it is only necessary to withdraw the analyser prism;

XUM

Bertrand's lens, etc., from the body, and substitute for the polariser an achromatic condenser.

W. F. S.—If you succeed in using your achromatic condenser satisfactorily with the limited means at your disposal, it can only be at the cost of infinite care and patience. It must be recognised that to use a condenser of large aperture efficiently it requires as much care in adjusting as an objective of large aperture. You ought, therefore, to provide yourself with a rack-work focussing substage, with centreing screws to make the condenser quite true with the objective ; a simple sliding tube is really not enough for good work.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. CROSS, KNOWLEDGE *Office, 326, High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

PERRINE'S COMET (1902 B).—This object was very favourably visible when near the zenith in the clear moonless evenings during the early part of October, but, though pretty conspicuous to the naked eye, it never developed into a really large and imposing comet. Rapidly traversing a path which successively carried it through the stars of Perseus, Cassiopeia, Cepheus, and Cygnus, and thence to the S.W., it entered the equatorial constellation Ophiuchus on about October 17th. On November 1st the comet will be situated about 43° east of the sun, and will set about 3½ hours after that luminary. About an hour after sunset the comet will be placed some 23° above the S.W horizon, and may be found 4° N.W. of the star μ Ophiuchi (mag. 4·7). On November 3rd the object must be looked for 4° W. of the star. On November 9th it will be seen about 5° N. of η Ophiuchi (mag. 2·6). The comet will exhibit a perceptible decline in brightness from night to night (while its apparent motion in the firmament will become markedly slower), so that when moonlight strongly interferes with observation after the first week in November, it will practically disappear as a suitable object for ordinary telescopes.

FALL OF A METEORITE IN IRELAND.—On September 13th, at about 10.30 a.m , some men at Crosskill, Crumlin, Co. Antrim, were working in a field when they heard a noise caused apparently by some explosion, and this was succeeded by a sound similar to that of escaping steam, or a train on the line, only much louder. On looking in the direction from whence the sound proceeded, the men saw something descending with lightning speed into the wheat field adjoining, and portions of the soil were thrown up a considerable distance into the air. Mr. Andrew Walker, on whose farm the meteorite alighted, says it fell vertically, for it made a perpendicular hole, and the corn standing round was not disarranged in any way. The stone was quite hot when taken from the hole about a foot and a half below the surface. It was an irregularly shaped mass of a dark metallic colour, slightly tinged with something like gold. There was a piece broken off, apparently at an earlier date, and was about nine and a half pounds in weight. It was cracked, probably by contact with a large field stone which it met with on embedding itself in the soil. Mr. L. Fletcher, of South Kensington, visited the spot, and purchased the meteorite for the British Museum, so that we may expect to hear more particulars of the interesting phenomenon.

FIREBALLS.—These brilliant objects were very numerous in August and September, and the following are brief references to a few of the most important : —

August 20, 10h. 31m., G.M.T.—Fireball lit up the sky with a glare which dimmed the light of the full moon. Path from 245° + 22° to 210° + 12°. Duration, three seconds.—Rev. W. F. A. Ellison, Enniscorthy.

August 22, 6h. 35m.—Large meteor as bright as the moon seen at Trinidad, W. Indies. It appeared in Capricornus, and shot to Coma Berenices.—Newspaper account.

August 24, 7h. 0m.—Brilliant meteor observed at Colombo, passing from N. to S., and bursting into a blaze of light. The dazzling flash terrified the natives, and served to enhance the apprehension regarding the earthquake and similar disasters prophesied by Indian astrologers for the end of the month.—Newspaper account.

August 25, 10h. 31m.—Fine meteor exceeding the lustre of Venus. Path from about 260° + 83° to 163° + 43°. Duration 2·1 seconds.—T. W. Backhouse, Seaton Carew, near West Hartlepool.

August 26, 15h. 13m.—Fireball brighter than Venus shot from 305° + 40° to 290° + 15°, and left a streak for 1½ minutes.—G. M. Knight, London.

September 6, 8h. 30m.—A magnificent meteor seen from the English Channel, London, and Shropshire, but not very exactly recorded.

September 12, 13h. 47½m.—Meteor equal to Sirius soared slowly across the southern sky, traversing a path of about 45° in 3½ seconds. Position 350° + 30½° to 306° + 18°, and radiant near the eastern horizon between 93° + 2° and 103° − 5°.—Prof. A. S. Herschel, Slough.

September 19, 10h.—Remarkably large meteor appeared in the N.W., not very far above the horizon, and remained visible about half a minute. It had a pear-shaped head, and fell almost vertically. —The Hon. Cordelia Leigh, Kenilworth.

September 25, 7h. 35m.—Brilliant flashing fireball observed by the Rev. W. F. A. Ellison, Enniscorthy, and also by the writer at Bristol. The former recorded the path as from 340° + 31° to 356° + 17°, while the latter gave it 211° + 41° to 204° + 38½°. The radiant was at 255° + 46°, and the height of the meteor 88 to 57 miles over the sea, between Cardigan Bay and the St. George's Channel. The length of the luminous course was about 34 miles, which it must have traversed with very exceptional velocity, for Mr. Ellison estimated the duration of flight as certainly not more than one-eighth of a second! At Bristol the actual descent of the meteor was not seen, but the flash caused the observer to look upwards, and the path was recorded by the transient streak.

September 27, 7h. 42m.—Large meteor brighter than Venus, seen by Rev. W. F. A. Ellison, at Enniscorthy, moving from 290° + 3° to 298° − 7°, and lighting up the country. Duration 1½ seconds. This object was also observed by Mr. A. Sullivan, of Dundrum, Co. Dublin, with a path from ε Aquari to within half a degree of Jupiter.

THE FACE OF THE SKY FOR NOVEMBER.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the sun rises at 6.54 and sets at 4.33 ; on the 30th he rises at 7.43 and sets at 3.54. The equation of time is at maximum on the 3rd, when the sun is 16m. 20s. before the clock.

Sunspots may be looked for.

THE MOON :—

	Phases.	h. m.
Nov. 8	☽ First Quarter	0 31 P.M.
„ 15	○ Full Moon	5 7 P.M.
„ 22	☾ Last Quarter	7 47 A.M.
„ 30	● New Moon	2 4 A.M.

The moon is in apogee on the 5th, and in perigee on the 17th.

The following are among the more interesting occultations visible at Greenwich :—

Date.	Star Name.	Magnitude.	Disappearance.			Reappearance.			Moon's Age.
			Mean Time.	Angle from N. Point.	Angle from Vertex.	Mean Time.	Angle from N. Point.	Angle from Vertex.	
			h. m.	°	°	h. m.	°	°	d. h.
Nov. 9	B. A. C 7717	6·5	5 33 P.M.	47	61	6 49 P.M.	266	267	9 10
„ 21	60 Cancri	5·7	0 6 A.M.	94	134	1 7 A.M.	241	328	20 17
„ 24	*v* Leonis	4·5	2 14 A.M.	69	107	3 0 A.M.	333	9	23 19

THE PLANETS.—Mercury is a morning star, and is near α Librae on the 20th. He attains his greatest westerly elongation of 18° 50′ on the 4th, when he rises about 5 A.M., the diameter of the planet is then 6″·8.

Venus is practically unobservable, being in superior conjunction with the sun on the 29th.

Mars is becoming more conveniently observable. About the middle of the month the planet rises half-an-hour after midnight and his path is situated in Leo. On the 17th he will appear in the same field of view as the fourth magnitude star χ Leonis. The diameter of the planet is increasing, being now about 5″·5, whilst 0·91 of his disc appears illuminated.

Jupiter can be observed during the early part of the evening; at the beginning and end of the month he is on the meridian at 6.5 P.M. and 4.26 P.M., and is therefore

most suitable for observation as soon as it is dark; on the same dates he sets about 10.30 P.M. and 9 P.M. respectively. His polar diameter is diminishing, being 37″ on the 1st and 34″ on the 30th. He is in quadrature with the sun on the 2nd at 2 A.M.

The following are among the more interesting of the satellite phenomena visible at Greenwich:—

Day.		H. M. P.M.	Day.		H. M. P.M.
Nov. 6.	I. Sh. I. ..	5 18	Nov. 21.	I. Oc. D. ...	5 11
	I. Tr. E. ...	6 18		I. Ec. R. ...	8 45
	I. Sh. E. ...	7 38		IV. Ec. D. ...	8 56
	III. Oc. R. ...	7 46	„ 28.	II. Sh. I. ..	4 49
	III. Ec. D. ...	9 32		II. Tr. E. ...	5 15
„ 13.	IV. Sh. E. ...	5 39		I. Oc. D. ...	7 10
	I. Tr. I. ...	5 55		II. Sh. E. ...	7 44
	I. Sh. I. ...	7 14	„ 29.	I. Sh. I. ...	5 34
	III. Oc. D. ...	8 10		I. Tr. E. ...	6 42
	I. Tr. E. ...	8 15		IV. Tr. I. ...	7 43
	I. Sh. E. ...	9 34		I. Sh. E. ...	7 55
„ 21.	II. Sh. E. ...	5 8			

Saturn is an evening star, setting on the 1st about 9 P.M., and on the 30th about 7.30 P.M. The best time for observing the planet is during the earlier part of the month immediately after dark. The ring is widely open and northern surface visible. On the 6th of the month Saturn is in conjunction with the moon at 5 P.M.; the planet being 5½° to the south.

Uranus is approaching conjunction with the sun and cannot be observed.

Neptune is well placed throughout the month, rising on the 15th about 7 P.M. The planet is still close to μ Geminorum, and may be seen in the same field of view with a low power. On the 1st their respective positions are:—

	R. A.	Declination.
Neptune ...	6h. 15m. 22s.	N. 22° 16′.
μ Geminorum	6h. 17m. 6s.	N. 22° 34′.

THE STARS.—About 9 P.M. at the middle of the month, the following constellations may be observed:—

ZENITH . Cassiopeia.

SOUTH . Andromeda, Pisces, Cetus; Pegasus, Aquarius towards S.W.

WEST . Aquila, Cygnus, Lyra a little north of west, Corona N.W., setting.

EAST . Auriga, Perseus, Pleiades, Taurus; Aries to the S.E.; Orion rising S.E.

NORTH . Ursa Major, Ursa Minor, Cepheus; Draco a little west of north.

Minima of Algol will occur on the 5th at 9.55 P.M., 8th at 6.44 P.M., 25th at 11 38 P.M., 28th at 8.26 P.M.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of October Problems.

No. 16.

Key-move.—1. Kt to B4.

If 1. . . . Q × B, 2. R to K5ch, etc.
1. . . . Q to B3, 2. Q × BP, etc.
1. . . . Kt to R3, 2. R × Q, etc.
1. . . . Q to K3, 2. R × Q, etc.
1. . . . P to Kt4, etc., 2. Q to B7ch, etc.

[There are duals after Q × R, by 2. Q to B7ch, or 2. Q × KtPch; after K × R, by 2. Q × BPch, or 2. Q to Kt6ch; after Q to Kt2, by 2. Q × BP, or 2 Q to B7ch; after Kt to B3, by 2. Q × KtPch, or 2. R × Q; after P to Kt3, by 2 Q to B7ch, or R × Q. There is also a triple continuation after Q to Q3, and a quadruple after Q to Ksq. Evidently some of these might have been stopped.]

No. 17.

Key-move.—1. R to Kt4.

If 1. . . . K to K2, 2. Kt to B8ch, etc.
1. . . . K to K4, 2. B to B4ch, etc.
1. . . . B to Kt2, 2. Q to Rsq. ch, etc.

[The same applies to 1. . . . P × R and R × KtP, etc. with varying mates.]

1. . . . R × Q, 2. Kt to Q5ch, etc.
1. . . . R × BP, 2. Q × R (R4) ch, etc.

[After P × P and other moves, there is a dual by 2. Q to Rsq. ch, or 2. Kt to Q5ch; and after R to Kt6 a triple, by the same two moves and 2 Q × Rch.]

No. 18.

Key-move.—1. R to K6.

If 1. . . . QP × R, 2. Q × Pch, etc.
1. . . . P to Q3, 2 R × Pch, etc.
1. . . . K × R, 2. Q to B6ch, etc.
1. . . . B to Kt4, 2. R × Bch, etc.
1. . . . R to R2, 2. B × P, etc.
1. . . . Others, 2. Q × B, etc.

After some hesitation I have come to the conclusion that a solver cannot score points for a triple, quadruple, etc., when he has already scored them for a dual in which *any two* of the continuations occur. For example, the triple in No. 17 is in reality only a repeated dual, with an additional continuation thrown in. It cannot score, therefore, for a solver who has already scored for the dual. So also the triple in No. 16 does not score for those who have claimed the duals after Q × R and Q to Kt2; while the quadruple would not score when any other dual has been claimed, except that after K × R.

SOLUTIONS received from W. Nash, 8, 5, 3; "Alpha," 4, 0, 0; W. Jay, 9, 5, 4; G. Woodcock, 5, 4, 4; "Tamen," 8, 4, 4; C. Johnston, 6, 5, 4; "Looker-on," 9, 5, 4; J. W. Dawson, 6, 4, 4; Lt.-Colonel Damania, 4, 4, 4.

W. Nash.—The dual claimed in No. 18 does not appear to be correct, *e.g.*, 1. . . . P to Kt4; 2. R × R, P × R; 3. (?). Your claim in No. 16, after "P moves," was also incorrect, but as you distinctly stated that you claimed nothing for it, I have been able to deduct nothing.

"*Tamen.*"—Both your letters bore the correct post-mark this time.

J. W. Dawson.—Your claim for dual in No. 17 after 1. . . . B to K7, by R × P, etc., does not appear to be correct. Black replies 2. . . . R × KtP or B to Kt2. Certainly a composer may vote for his own problem, and place it wherever he thinks fit; and such vote will carry equal weight with others. This, in fact, is a necessity, as the composers of the problems will not be known to me till some time later.

Lt.-Col. Damania.—Key-moves only are preferred, but during the progress of the Problem Tourney points are being awarded for duals on the second move.

XUM

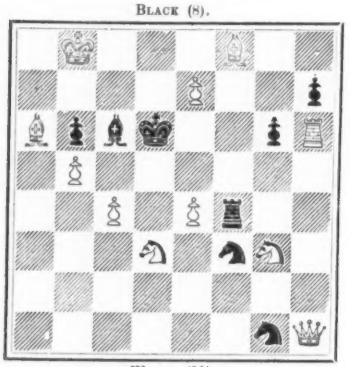
G. W. Middleton.—I regret to receive no solutions from you this month; more especially as I had hoped to have you on the "jury" at the end of the year.

PROBLEMS.

No. 19.

"Circumstances alter cases."

BLACK (8).



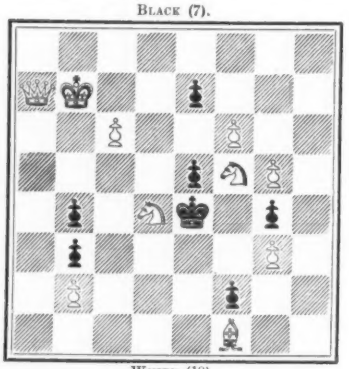
WHITE (11).

White mates in three moves.

No. 20.

"All's well that ends well."

BLACK (7).



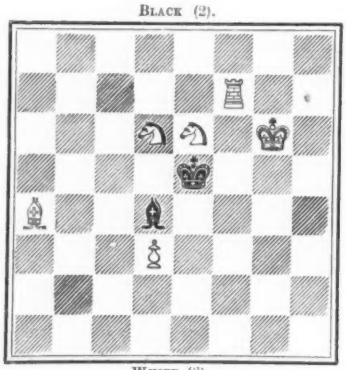
WHITE (10).

White mates in three moves.

No. 21.

"True Blue."

BLACK (2).



WHITE (6).

White mates in three moves.

The scores of the six leaders in the Solution Tourney are now as follows:—

W. Jay ...	... 89	J. W. Dawson ...	72
"Looker-on"	... 84	C. Johnston ...	71
W. Nash	... 83	G. Woodcock .	66

Mr. Jay has increased his lead and should be difficult to overtake; but there will at any rate be a desperate struggle for second and third prizes. I sincerely hope that none of the above will retire before the *end* of January, when the last Tourney Problem will have appeared. Otherwise the number of the jury will indeed be limited, the above six alone being now eligible to serve. The Solution Tourney, of course, ends with the problems published in the December number.

I am unable to find the problem "Aller guten Dinge sind drei." The sealed envelope is also missing, and it is not likely that both can have been mislaid. I can only guess, therefore, in the absence of evidence to the contrary, that the composer must, some months ago, have withdrawn the problem, and that the fact has escaped my memory. Should the composer see this, I trust that he will let me know the facts.

CHESS INTELLIGENCE.

Mr. F. J. Marshall has recently defeated Mr. R. Teichmann in a short series of games, winning two and drawing the other three. A small tournament in Paris resulted in the following score:—D. Janowski, 4½; S. Taubenhaus, 3½; Von Scheve, 3; A. Albin, ½.

Two eminent chess masters have passed away during the last month. One, M. Rosenthal, was for many years the best player in France, eminent alike as a theorist and a practical player. He is chiefly remembered in England for his game against Steinitz, which won the brilliancy prize in the London Tournament of 1883. The other, C. A. Walbrodt, of Berlin, was an even stronger player. He did not do himself justice in the Hastings Tourney, but at his best he was probably among the first six European players. His death occurred at the age of 31.

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